PROGRAM OR PROFITS?
TRADITIONAL VERSUS NONTRADITIONAL LINKAGES FOR THE COMMERCIAL DEVELOPMENT OF OUTER SPACE

By

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by

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For Ron

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PREFACE

Anthropologists are not generally associated with the U.S. space program or the National Aeronautics and Space Administration (NASA). Yet the space program provides a rich and varied setting in which to investigate numerous questions concerning human physiological and cultural adaptations to hostile environments, diffusion of advanced technology to society, and management and evaluation of complex and multicultural technical programs. A brief description of how the present research project came about is offered here to provide additional insight into the evolution of the study and to illustrate the difficulties encountered by a social scientist working in advanced technological arenas.

My original research goal was the study of private sector organizations, an area I feel has been somewhat neglected by mainstream anthropology since the 1950s. During the course of my graduate career at the University of Florida I took advantage of opportunities for formal training in industrial engineering, corporate strategic planning, and organization development through the Colleges of Engineering and Business Administration. In the former

area, I was introduced to concepts of operations and workflow in high technology R&D. In the latter area I gained an understanding of the financial orientation of most corporate planners and strategies, including costs and benefits of corporate decision making as expressed in financial risk and return on investment parameters.

Also in the latter area, I became aware of two things. First is the dominance of behaviorist orientations that underlie the majority of models of organization processes as well as the specific techniques, or interventions, utilized by organization development practitioners to solve problems of organization dysfunction. Second is the significant misfit between organizational theory and its applications to organizational problem-solving by these same practitioners. As a consequence, my research activities have focused on ways to reconcile the major theoretical approaches to complex formal organization and the translation of those approaches into natural field experiments that can, in turn, amplify existing theoretical perspectives.

Given these interests, the next task was to decide on a particular industry on which to focus my research efforts. After much thought I discovered that one industry in particular--the space industry--was of special interest to me. Areas for investigation include the organization and interactions among aerospace corporations, activities associated with the design and construction of satellites

and launch equipment, astronaut training and mission operations (particularly with multicultural crews representing a variety of national and corporate interests), planning for the space station and long term human habitation of the space environment, and project organization and management operations utilized by NASA, the U.S. civilian space agency.

Fortuitously, I was directed to Mr. J. Ronald Thornton, Director of the Southern Technology Applications Center (STAC) headquartered at the University of Florida and affiliated with the College of Engineering. STAC is a NASA Industrial Applications Center (IAC) originally chartered to transfer information and technology developed by NASA to the private sector for additional development, commercialization, and/or incorporation into business and industrial operations. Mr. Thornton proved to be extremely knowledgeable with regard to NASA both as STAC Director and from experience as Deputy Director for Technology Utilization at NASA Headquarters in Washington, D.C.

Mr. Thornton provided invaluable assistance in the form of discussions, access to NASA reports and other publications, as well as encouragement. Even more importantly, however, he introduced me to a new program under development in the federal government based on the Reagan administration's October, 1984, endorsment of NASA's Commercial Use of Space (CUS) Policy. The policy encourages

greater participation of the private sector in space-related activities as a precursor to eventual private sector control of many space activities now operated by Government (i.e., NASA). Over a period of several months, Mr. Thornton and I discussed aspects of NASA, commercialization of space initiatives, and NASA's network of Industrial Applications Centers in a variety of broad contexts including technology transfer, organizational linkages, and federal and state advanced technology and economic development strategies.

Subsequently I was invited to participate in a policy research effort at STAC concerning the commercialization of university-generated technology. This led me, in turn, to more extensive studies of the strategic relationships between and among universities, state and federal government agencies, and business and industrial organizations for advanced technology and economic development in the United States. As a result of this informal training, I am now familiar with advanced technologies and engineering, with the challenges of creating new advanced technology businesses, and with the major national strategies for linking government, universities, and the private sector to accomplish advanced technology business and economic goals.

NASA also has a long history of multi-organizational linkages through which information, technology, and other intellectual property are made available to the private sector for business and industrial development. Business

and industry utilize the transferred information and/or technologies to upgrade and modernize factory production processes, streamline operations, improve existing products, or develop new products and services. Thus, technology transfer via deliberately and formally structured interorganizational linkages is a tradition upon which the development of commercial space activities is being built.

The second task was to convince administrators and program managers at NASA that the commercial space program was a useful and reasonable arena for study from a social science perspective. This proved difficult, primarily because traditional areas of research within NASA are those associated with aerospace and other areas of engineering, space science, computer science, and the life sciences. Social science, particularly anthropology, is neither well understood nor associated with the space program by NASA personnel concerned with "tin bending," the construction of physical structures and propulsion systems for spaceflight and orbiting space stations.

My first attempts to introduce NASA personnel to an anthropological analysis of NASA-industry organizational linkages did not succeed. One attempt was a fellowship application to study interorganizational linkages pertaining to spaceflight activities carried out by multicultural crews with differing organizational affiliations. For example, Dr. Charles Walker is a "corporate" astronaut from McDonnell

Douglas Corporation, other astronauts represent foreign countries, and still other astronauts are those drawn traditionally from the elite corps of U.S. military flight test pilots. Research questions centered around decision-making during on-orbit activities, organizational affiliation and the relative power of corporations, foreign governments and U.S. government agencies in determining ad-hoc on-board decisions, and other interorganizational linkage factors that might affect on-orbit activities.

The application was passed from one NASA division to another to find the appropriate proposal evaluators, and it was ultimately reviewed by the Life Sciences Division of the Office of Microgravity Science and Applications because the research focused on people. The life sciences staff rightly declined to fund this application on the grounds that it was not within their research focus on human physiological responses to microgravity environments. The research setting was the CUS program but none of the NASA evaluators apparently thought to refer the proposal to the Office of Commercial Programs for review.

The rejection, based on nonconformity to traditional and ongoing natural science research projects in support of spaceflight, illustrated both the novelty of research on organizational linkages and an apparent lack of communication between divisions within NASA itself. Ironically, the Challenger tragedy occurred during review of

this research proposal. Within a short time, it became known to the general public that the launch decision may have resulted from organizational incompatibilities within the linkage relationship. A letter relating the preliminary Challenger findings to my own research proposal apparently had no effect on the ultimate outcome of the proposal evaluation.

Other early attempts (pre-Challenger) involved interviews with three very cordial and knowledgeable program managers at NASA Headquarters. However, when two of these individuals learned that I was an anthropologist, precious interview time was lost as they recollected their own discoveries of arrowheads and pottery and wanted to know how anthropology could possibly pertain to anything at NASA. These problems were overcome when, during later interviews, I (regrettably) refrained from any mention of anthropology. The third individual, Dr. B. J. Bluth, a sociologist working with the Office of Space Station at NASA Headquarters, gave me much encouragement, advice, and insight into the engineering perspective of almost all NASA personnel.

During this time I was invited to become a regular staff member at STAC and to provide policy and other background research capabilities in support of STAC's technology transfer and commercialization activities. The position at STAC provided me with additional opportunities

to interact with NASA program personnel as the NASA IACs were gradually brought into CUS activities.

IAC involvement in the CUS program came about as a consequence of reorganization and consolidation of several program elements at NASA Headquarters, particularly elements in the Office of Space Station and the Office of Commercial Programs. The Office of Space Station among other things develops private sector companies as regular "users" of the station, while the Office of Commmercial Programs utilizes its national network of IACs to interact regularly with private sector companies. As a way to minimize duplication of effort within the broader area of commercial space, the IACs have become a natural vehicle for "Outreach," that is, soliciting business and industry involvement with NASA in the context of CUS and the space station programs.

The official sanctioning of IAC involvement in the CUS program provided me with the means to open doors at NASA previously closed. Interest at NASA began to turn to the problems of creating and managing interorganizational linkages with non-aerospace companies. While mandated by the Reagan administration to provide commercial opportunities for involvement on a broad scale, NASA program managers were and are unsure about how to go about linking with non-aerospace companies, especially small high technology companies. I suspected that this was because

NASA administrators and managers had little contact with companies outside the aerospace industry.

Consequently, I submitted an "unsolicited proposal" to NASA that focused on ascertaining the levels of knowledge held by NASA CUS personnel about the non-aerospace companies with which NASA is mandated to link for the CUS program. However, unsolicited proposals are not the normal procedure at NASA. Proposals are generally solicited by NASA for NASA-defined topic areas, and it was not known how long it might take for proposal review to occur and for a decision to be made.

Thus, in an effort to carry out research on interorganizational linkages and the CUS program in a reasonable length of time, another research design was prepared at the same time as that for the unsolicited proposal. This proposal, however, did not concentrate on NASA CUS program organization and personnel directly. Rather, it examined the other half of the equation: the private sector companies targeted for potential commercial space involvement. The research on which this thesis is based stems from the latter project.

To summarize, this project is the result of a series of fortuitous events, the invaluable support of the members of my doctoral committee and Mr. J. Ronald Thornton of STAC, as well as several frustrating experiences at the outset. The study of interorganizational linkages is fascinating,

particularly in an arena such as the space program where new types of linkages with new types of organizational partners are underway. Perhaps this research will open doors for other anthropologists and social scientists at NASA and in other predominantly engineering and technology-based organizations.

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Chairman: Ronald Cohen
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Formalized cross-sector interorganizational relationships, or linkages, are an increasingly popular strategy for local, regional and national technology and economic development. Traditional linkage relationships between government, industry, and academic organizations are being augmented by nontraditional linkage formats. The assumptions are that technology development and diffusion are rational processes that can be planned, implemented, and controlled through new kinds of relationships among diverse organizations. More specifically, it is assumed that these novel multiorganizational relationships will fuel basic research, lead to spinoff technologies for subsequent commercialization by the private sector, create new or

revitalize existing industries, and promote regional and national economic growth.

The Commercial Use of Space (CUS) policy and related programs implemented through the National Aeronautics and Space Administration (NASA) illustrate these assumptions. The space program has not yet received systematic attention by anthropologists, yet it is fertile ground for investigation into a variety of sociocultural phenomena. In the context of the commercial development of outer space, NASA has targeted small and medium-sized nonaerospace high technology companies as potential partners for space-based and space-related research and development (R&D). An array of nontraditional agreements (linkage formats) has been implemented for this purpose. However, NASA's initial attempts at creating novel and nontraditional linkages among nonaerospace companies have been disappointing.

To understand why, extensive participant-observation of NASA-industry interaction was undertaken, high technology entrepreneurs and executives of small and medium-sized companies were interviewed, and 1200 such executives were surveyed nationally. The research was organized to investigate how organizational culture influences the creation and maintenance of cross-sector interorganizational linkages. A set of straightforward hypotheses was developed as heuristic devices to guide the investigation.

The findings suggest that 1) linkage creation depends on a priori perceptions about congruence, complementarity, and conflict between public and private sector organizational cultures, 2) organizations tend to adapt toward congruence and complementarity with concomitantly strong traditional linkage patterns so that new linkage formats are potential sources of interorganizational conflict, and 3) organizational adaptation most frequently occurs in the context of a formalized linkage to transform conflictive states into congruent or complementary ones.

CHAPTER ONE

INTRODUCTION

Statement of the Problem

Formalized relationships between organizations are increasingly important strategies for achieving a variety of complex, costly and large scale organizational, national and societal goals. Further, formalized relationships between organizations across sectors are growing in number and variety as government increasingly looks to business and academia for assistance in achieving technology and economic development goals. Nationalistic economic development goals encompass a variety of initiatives. These include improved education at all levels but particularly in science and mathematics, the stimulation of entrepreneurship and other small business activity, the creation of new industries, the revitalization of existing industries, and the overall objective of recovering and/or maintaining the U.S. position as a powerful world leader in the development of advanced technologies essential for economic well being.

These goals and the programmatic strategies designed to achieve them are based on three powerful and increasingly popular assumptions about technology development and

diffusion. First is the assumption that technology development is a rational process that can be planned, implemented, and controlled. A related assumption is that advanced technology development is fundamentally related to U.S. economic well being, particularly in the context of international competitiveness. The third assumption is that all phases of technology development can be controlled through the creation of new kinds of formal, albeit complex, multiorganizational relationships.

These three assumptions have achieved prominence in government at all levels during the past two decades, but their popularity has increased dramatically in recent years, notably via their incorporation by Congress into the Technology Transfer Act of 1986 and the 1988 Omnibus Trade Bill. As a consequence, federal and state policies are being crafted, programs are being designed, budgeted and implemented, and new social formations are being established to control and direct research, development, and commercialization of advanced technologies. In other words, authoritative interventions are designed to drive technology development and control its diffusion and effects in other cultural arenas.

Technology and economic goals such as these are ambitious, complex, costly, and it is assumed that they cannot be left to the vagaries of market forces or political whim. Rather, they must be planned and managed carefully.

For example, the Technology Transfer Act of 1986 mandated, among other things, that technologies developed as a result of government sponsorship be transferred as speedily as possible to the private sector for continued development and commercialization. As part of the 1988 Omnibus Trade Act Congress renamed the National Bureau of Standards to the National Institute of Standards and Technology (NIST) and expanded the mission of the organization to include technology development and transfer activities. The U.S. Departments of Commerce and Defense are currently stepping up activities designed to stimulate the development of advanced technologies, particularly in areas related to international commerce, national defense, and the domestic economy.

States, too, are actively pursuing state and regional economic development strategies which rely on formalized relationships between government and industry as well as academia. Florida, for example, is linking universities and industrial organizations to improve applied research programs and to transfer the results more effectively to business and industry for commercialization. Many states, including Pennsylvania, Ohio, Massachusetts, Texas, and Michigan, have developed state-sponsored seed and venture capital funds for investment in start-up and small advanced technology businesses. Government agencies formally link to

private sector companies to capitalize and operate these funds and other programs.

Government at all levels is actively developing consortia composed of industry, academic, and government organizations for the development of advanced technology. On the federal level, the National Aeronautics and Space Administration (NASA) has developed Centers for the Commercial Development of Space (CCDS), and the National Science Foundation's Engineering Research Centers Program is another well known example. On the state level, Pennsylvania has established a Center for the Development of Advanced Technology at each of four regional universities, while Florida has established various Centers of Excellence at the nine universities in its State University System. State programs mirror federal programs in that a strong industry commitment reinforced through formalized linkage relationships to government and/or academic organizations is required in each case.

Not only is there concern in the United States about the development of advanced technologies as a cornerstone of economic development. Such concerns are prominent as well in Japan, the USSR, Europe, China, Sweden, the United Kingdom, and elesewhere. Here, too, technology and economic development strategies often center around the development of novel relationships between government, industry, and academic organizations. Sweden's Technical Attache System,

for example, has been called "a worldwide model of industry-government cooperation and technology transfer" (Myers 1989: 6).

Thus, questions about interorganizational relationships, or linkages, formalized via legally binding contracts or agreements, are important for theoretical and practical reasons. Theoretically, shifting currents of interorganizational relationships provide opportunities for investigating the creation and change of social formations both in the U.S. and cross-culturally. Practically, the question of whether or not such linkage strategies result in advanced technology and economic development is of concern to policy makers, program managers and recipients of organizational actions.

A fundamental question for both scholars and practitioners alike is how do important differences between organizations from different sectors affect the formation, maintenance, and outcomes of formalized linkages? While each organization is unique, it is generally assumed that organizations which are part of any one sector have more in common with one another than they do with organizations that are part of other sectors. Intra-sectoral differences notwithstanding, it is generally assumed that private sector organizations differ distinctively from both public and academic sector organizations and that public sector

organizations differ very clearly from private and academic sector organizations.

The nature and extent of such differences, however, are difficult to determine since they span a number of organizational elements including goals, values, operations, decision making processes, and environmental contexts. Private sector organizations, for example, are characterized by their orientations toward profits and their simultaneous dependency on the marketplace and environment for continued existence. Thus, business and industrial organizations produce goods and services for sale in a competitive market. Ideally the goods and services are sold for an amount in excess of what was required in their development, production, and distribution. The excess, or profit, is then turned back into the organization and/or paid in the form of dividends to shareholders. Profits enable development of new products, refinement of existing products, and accomplishment of other activities necessary for maintaining the organization's viability. Failure to meet these criteria can result in the demise of the organization.

Public sector organizations, on the other hand, act to regulate the marketplace and/or to provide services considered essential to social and community life. Services are not "sold" in a market environment but are the direct outcome of revenues acquired through taxation and other

collective activities. Principal tasks for government agencies include the redistribution of wealth in the form of services, regulation of activities critical for smoothly functioning societies, and maintaining their own stability over time.

Academic organizations can be found in both the public and private sectors. Despite this fact, however, academic organizations share similarities that distinguish them from both business and industry on one hand and government on the other. Similarities include the primary goals of discovering and transferring knowledge throughout society.

One way to determine the extent of differences between organizations from different sectors is to examine them in the context of linkage relationships. The growing number and variety of linkage arrangements between diverse organizations for major national and regional technology and economic development provide especially promising opportunities for exploring the nature of both traditional and new linkage relationships between organizations, the impact of sector-related differences on the linkage relationships, and the utility of such relationships for achieving ambitious, complex, and costly national technology and economic development goals.

Much of the social scientific research conducted on interorganizational relationships has been in the form of case studies of linkages among organizations within a single

sector. Few studies have been carried out on formalized relationships between organizations that are part of different sectors, such as a private sector company linked to a public sector government agency. While such linkages are certainly not new and, in fact, form a strong basis for much government-industry interaction such as government sponsorship of university or industry research, cross-sector linkages have not been a frequent subject of scientific scrutiny.

This study, then, focuses on the problem of formalized relationships, or linkages, between organizations which are resident in different sectors. More specifically, it explores the influence exerted by sectoral differences between organizations on linkage relationships and the achievement of predetermined linkage goals. The remainder of this chapter describes the setting in which cross-sector interorganizational linkages are explored: the commercialization of outer space and its growth and development within the National Aeronautics and Space Administration (NASA). The chapter concludes with a discussion of the significance of the research for the more general theoretical issues of cross-sector organizational linkages and for more practical questions associated with linkages as principal vehicles for technology and economic development in the U.S.

The Research Setting

The setting for this research is the U.S. civilian space program as developed and carried out by the National Aeronautics and Space Administration (NASA). More specifically, the study focuses on cross-sector organizational linkages formed within the context of NASA's Commercial Use of Space (CUS) Program.[1]

This setting was chosen for three reasons. First, social scientists and particularly anthropologists have not yet directed significant attention to the U.S. space program. Preliminary review of the nontechnical literature on the space program reveals major concentrations of effort on the physiological and psychological requirements for living and working in the space environment (e.g., Cohen, Eichold, and Heers 1987, Douglas 1986, Kanas 1985, Bluth 1981 and 1984, Helmreich, Wilhelm, and Runge 1980, Rudoff 1978, Cheston 1977, Eilenberg and Eilenberg 1977, Shurley, Natani, and Sengel 1977, and Cooper 1976) and on broad economic and legal parameters influencing the direction and composition of space policy and activities (e.g., Gwynne

[1] The term "program" is used throughout this study to denote a substantively unified but administratively diverse goal-oriented set of activities carried out by a wide variety of individuals in government, academia and the private sector. NASA usage of the term differs in that "program" denotes a more strictly bounded set of activities regulated by operational, administrative, and accounting parameters. Many NASA administrators, therefore, may not agree with categorizing the diverse activities and participants in commercializing space into a program.

1986, Covault 1985, Hosenball 1983 and 1984, Egan 1984, DeSaussure and Haanappel 1982). With the exception of Sayles and Chandler's (1971) analysis of NASA organization and project management during the Apollo program, virtually no sustained and systematic social scientific research has been conducted on NASA itself and its relations to other organizations. Interest has reawakened, however, in the aftermath of the Challenger tragedy and subsequent findings of the Presidential Commission (1986) about the critical role played by intraorganizational dynamics and interorganizational relationships in the decision of whether or not to launch (see Vaughan 1989 and McConnell 1987).

Second, the Commercial Use of Space program provides an opportunity to observe and analyze the creation and maintenance of new types of linkages between NASA and business organizations. The linkages necessary for CUS program success differ from traditional NASA-industry relationships in that the latter cast government into the role of "purchaser" of industry products and services. Government-as-consumer mandates the terms of the relationship and the quantity and quality of goods and services procured. In contrast, CUS linkages stress joint working relationships and more egalitarian decision-making for both NASA and its industrial partner(s) in a commercial space activity.

The third reason for locating the research within the CUS program is that the program also requires NASA to link with new types of business and industrial organizations. Traditionally, NASA has contracted almost exclusively with firms in the aerospace industry. These firms are largely dependent on federal contracts for their continued existence and, over time, have adapted their structures and operationing procedures to compete for large federal contracts, such as those from NASA and the Department of Defense (DOD). Such organizational adaptations, in turn, have fostered a set of expectations on the part of federal program managers. These expectations relate to the identification of potential linkage partners (i.e., aerospace companies), dissemination of information about government needs and Requests for Proposals (RFPs), evaluation of proposals, and contract management.

Historically, NASA and the aerospace industry have developed strong interorganizational dependencies that have been both beneficial and harmful. One benefit has been the development of a community of specialists who interact regularly across organizational boundaries in order to solve the extraordinarily complex technical problems of both manned and unmanned spaceflight. The interaction of these individuals occurs by virtue of complex organizational linkages formalized in prime contracts with NASA and in subcontracts with each other. Additional interaction is

accomplished through complicated movements of individual experts between and among NASA and the aerospace companies via consultantships, sabbaticals, temporary assignments, and other personnel exchanges.

There are several drawbacks as well to such strong interdependencies. One drawback is the fact that they present extremely strong barriers to entry for new firms. A second drawback is the general potential for corruption and organizational misconduct that can result from attempts by organizations to maintain and/or improve their positions within an interorganizational network and to prevent the entry of additional competitor organizations.

A third drawback is the effect of the interdependencies and adaptations on the expectations of individuals within the interorganizational context. NASA managers, for example, generally assume that aerospace companies can meet all NASA's needs. They rarely look beyond the aerospace industry for companies that may be able to provide goods and services. After all, the aerospace companies are well understood, employ people with prior experience in working on NASA projects, and are already familiar with NASA's complicated contractual, accounting, and quality control requirements and procedures. At the same time, aerospace companies continuously adapt their capabilities to NASA's (as well as other government agencies') increasingly diverse needs so as to ensure their own continued viability.

The space program, thus, provides an excellent setting for anthropological research. The novelty of the CUS program itself and NASA's concomitant mandate for new types of interorganizational relationships and new, unfamiliar organizational partners provide a rich setting for research on a variety of topics. This is especially true for the study of the formation, maintenance, and outcomes of formalized interorganizational linkages. From a theoretical standpoint, the setting allows for the exploration of models of organization and change in the context of interorganizational relationships. On a more practical level, the setting provides an opportunity for the development of a specific set of recommendations for subsequent field testing within the context of the CUS program. Natural field experiments can, in turn, form the basis for subsequent evaluation research into cross-sector interorganizational relationships.

History of the Commercial Use of Space (CUS) Program

In August, 1984, Dr. Charles Walker of McDonnell-Douglas Astronautics Co. became the first commercial researcher to work in outer space as an astronaut aboard the U.S. space shuttle Discovery (Osborne 1985). Walker's presence and work during that shuttle flight represented an important new direction for U.S. activities in the space environment.

This new direction was signalled earlier by President Reagan in a presidential directive issued with the National Space Policy on July 4, 1982. This directive stated, in part:

> The United States encourages domestic commercial exploitation of space capabilities, technology, and systems for national economic benefit . . . .
>
> The United States Government will provide a climate conducive to expanded private sector investment and involvement in space activities, with due regard to public safety and national security. (Ronald Reagan 1982: 895-896)

This directive was reinforced in 1983 by statements of support for increased commercial opportunities for the private sector in space issued by the U.S. House of Representatives Committee on Science and Technology (Smith 1983) and the U.S. Senate Committee on Commerce, Science and Transportation (Smith and Zafran 1983). Accordingly, NASA developed a Commercial Use of Space Policy that was endorsed by President Reagan in October, 1984, followed by subsequent endorsements at all levels of the federal government.

The policy encourages significant levels of private sector involvement in the development of the space environment for commercial activities. It contains several initiatives that define NASA's roles in 1) stimulating research and development, 2) facilitating access to NASA facilities and equipment, 3) developing procedures to support space commercialization, 4) enhancing industry

access to the NASA organization, 5) establishing new links with private sector companies, and 6) supporting the U.S. National Space Policy. A summary of the policy is presented in Appendix A.

While the CUS policy represents a new direction for much of the U.S. space program, it is an outgrowth of several historical factors. First, U.S. business and industry have already commercially developed, marketed, and profited from technological innovations generated by the space program. These new technologies have been transferred to the private sector for further research and development leading to new products via NASA's Technology Utilization (TU) program. This program, currently part of the Office of Commercial Programs at NASA Headquarters, coordinates an extensive and successful technology transfer program as mandated originally in the Space Act of 1958. NASA's technology transfer program is the oldest and most well established program of its kind in the U.S.

The process has worked marvellously well, and private companies as well as U.S. citizens are benefitting from a plethora of "spinoff" products and technological advances that now comprise billion dollar industries. Computers, robots, food processing technologies, new fabrics for clothing and other uses, new metal alloys, new ceramic materials, new medical technologies (e.g., the pacemaker), weather forecasting, and satellite communications are just a

few of the significant commercial products and processes that have "spun off" from the space program.

Second, the infrastructure of universities, federal laboratories and commercial companies providing the services and facilities necessary to support both manned and unmanned spaceflight grew with the U.S. space program. Developers and suppliers of rocket boosters, computers, satellites, propellants, power systems, the launch pads, space suits, and other necessary elements of spaceflight have long been important ingredients of the space program. These activities have formed the traditional prime contracts and subcontracts that currently dominate NASA and aerospace company linkage relationships.

The third contributing factor is the growth of the worldwide communications industry. With estimated revenues of $3 billion annually (Osborne 1985) the communications industry clearly illustrates that profitable commercial activities are possible in the space environment. Communications satellites have transformed radio and television, expanded telephone communications, and provided for worldwide electronic transmission of mail and other communications. Additionally, continued developments within the space program in the areas of computer hardware and software, lasers, and miniaturization of electronic devices are certain to transform communications as well as other

industries (medicine, for example) even more radically in the next decade.

Thus, the necessary framework for the current CUS policy for increased private sector involvement in the space environment already exists. This framework is composed of established processes for transferring space technologies to the private sector for commercialization, an established infrastructure of private sector firms supporting the space program through the provision of goods and services, and a vision that other commercial activities in space can be as profitable and beneficial as the satellite communications industry.

The CUS program is designed to benefit several industry areas, including manufacturing, medicine, pharmaceuticals, transportation, mining, agriculture, textiles, and others, by encouraging involvement with NASA. New products envisioned by program managers and others include new metal alloys, new drugs, better medical diagnostic techniques, better aids for navigation by aircraft and ships at sea, more accurate weather forecasting and monitoring of general environmental conditions, improved techniques for locating minerals and ores, new materials for everything from machine components to clothing, more cost-effective energy sources, and many others.

These areas have been categorized within the CUS program into 1) materials processing in space (MPS),

2) earth and ocean observation (also called remote sensing), 3) communications, and 4) industrial services. Of these areas, materials processing (MPS) and remote sensing have received the most attention in the press and in NASA public relations materials. A number of MPS experiments during shuttle flights have demonstrated the desirability and utility of the space environment for the manufacture of new substances and products. For example, the microgravity (weightlessness) characteristic of the space environment allows the growth of perfect crystals for use in computer chips, lasers, solar power technology, and fiberoptic systems. Also, biological substances, such as the enzyme urokinase used in the treatment of pulmonary embolisms, can be made many times purer in microgravity.

This is because on earth, gravity causes heavier components in a mixture to sink to the bottom. To obtain a uniform mixture on earth, lots of (expensive) energy and equipment are needed for stirring, heating, cooling, and so forth. Even so, mixtures are not as uniform in texture as they could be or are desired to be. Thus, less-than-satisfactory metal alloys are a frequent occurrence while mixing very heavy with very light metals is frequently impossible altogether. During the cooling process, the heavy metals inevitably sink and the lighter ones rise.

Weightlessness in the space environment, on the other hand, results in virtually no sinking and rising of

differently weighted components. Concepts of "heavy" and "light" have little meaning; all things weigh the same, that is, nothing. New alloys are not only possible, but many common alloys can also be improved because the mixtures of light and heavy components are more uniform. The various characteristics of new, previously impossible metal alloys are likely to include extreme strength, heat resistance, electrical conductivity, durability, and flexibility among others. Thus, CUS program advocates regard the weightless characteristic of the space environment as an important "natural laboratory" condition that researchers can utilize to create new metal alloys for more fuel efficient and safer automobiles, airplanes, other vehicles, equipment, and other uses to numerous to mention.

NASA researchers have also learned that the space environment also improves the performance of many processing techniques first developed and used on earth. Heating and cooling of materials, for example, can be accomplished more rapidly. Separation of the elements of a mixture (such as through electrophoresis) is more efficient and effective and results in almost 100 percent purity of a desired component. Thus, materials processing in the space environment holds great promise for the development of new materials, the development of improved and new processing techniques and equipment, and significant increases in scientific knowledge

about the behavior of solids, liquids, and gases in physical conditions not present on earth.

While full-scale "space factories" will not be a reality for many years to come, the focus on MPS establishes the groundwork for that eventuality. Most NASA, business, and academic scientists feel that more immediate benefits from MPS will be in the form of new and/or better processes and materials for use in building space vehicles, equipment, and structures as well as in such commercial applications as automobiles, airplanes, components for equipment, and physical structures on earth.

Earth and ocean observation, or remote sensing, is the second industry area presently receiving significant attention. Currently, data are streaming down to earth at an astonishing rate from orbiting observation satellites. The accumulation of such data is staggering and includes information about the earth's atmosphere, pollution levels, urban sprawl, farming patterns, weather, and even newsworthy events such as the nuclear accident at Chernobyl in the U.S.S.R.

In contrast to MPS, the object of the CUS program is not to carry out basic scientific research but to encourage commercial companies to transform the enormous quantities of raw data already available from orbiting satellites into useable information. This information can then be offered for sale to farmers, urban planners, environmental and other

engineers, government agencies, and others. The major problem in this endeavor is identifying large enough markets for the information so that profitable enterprises can recoup the high costs of obtaining and transforming the raw data.

The third area of CUS activity is "industrial services." This area is not yet fully conceptualized by program managers at NASA; however, most CUS program managers agree that this area will build on the commercial infrastructure already established by traditional contractor-type NASA-industry linkage relationships. This is because the services and support envisioned for commercial activities in space will most likely be little different, at least initially, from those which are part of the existing infrastructure. That is, business and industry will supply NASA and other commercial space participants with equipment, component parts, maintenance and repair services, and other products and services needed to carry out space-based activities. Eventually, industrial services will include the provision of equipment, food and other life support system components, and launch services to support manned spaceflight, the space station, orbiting "space factories," and habitations on the moon and Mars. In time, it is projected to include maintenance activities on satellites, spacecraft, and other facilities.

While part of this infrastructure is already in place through an intricate network of prime contract and subcontract linkage relationships, the industrial services component of the CUS program is quite likely to incorporate a wider variety of formalized interorganizational relationships that are supportive of joint NASA-industry MPS and remote sensing objectives. It is widely believed that industrial services will comprise the largest sector of commercial space industries.

The final industry category of the CUS program area is communications and information systems. Within this category are satellite communications systems and computer systems for worldwide communications and electronic transfer of information. The communications industry is the most mature of the CUS program areas, even though it is not a primary focus of CUS at this time. It is included in NASA's CUS materials and publications because it demonstrates clearly that commercial space activities can be both successful and profitable. Most communication satellites now in orbit were built by private companies in conjunction with NASA and are operated by those companies for commercial purposes.

Relatively fewer linkages are involved between a satellite communications company and NASA compared with other areas under development within the CUS program. Satellite communications companies are likely to develop

agreements with NASA for maintenance and retrieval of disabled satellites by shuttle astronauts. Such agreements center around the reimbursement of NASA for costs of services rendered to the company in retrieving, refueling, repairing, and/or transporting the satellite to and from orbit. On the other hand, satellite communications companies interact continuously with regulatory agencies both in the U.S. and internationally (see, for example, Kildow 1973).

Prior to the loss of Challenger, linkage agreements included provisions for NASA to launch communications satellites into orbit. As a consequence, private companies had to conform to NASA specifications for satellite construction. These specifications covered size, weight, deployment processes, fuels, and the other elements necessary to carry the satellite safely on the manned space shuttle and to launch it into its permanent orbit. Thus, NASA retained its dominant position in contractual decisions regarding the design and operations of communications satellites.

The Challenger disaster and ensuing moratorium on shuttle launches created a backlog of satellites and other payloads to be launched. President Reagan, in an effort to establish priorities among the backlog of varied and important payloads, mandated that satellites and other similar payloads were no longer to be launched by NASA via

the shuttle, but by expendable booster rockets used by NASA, foreign space agencies, and fledgling U.S. commercial launch services.

This decision was designed not only to relieve the backlog of payloads waiting to be launched but also to stimulate the development of a U.S. commercial launch industry. However, the U.S. commercial launch industry has been slow to develop and as yet has only limited capabilities for launching heavy payloads, including many contemporary communications satellites that were designed in accordance with shuttle specifications rather than with expendable launch vehicle (ELV) specifications. Thus, most satellite communications companies have negotiated agreements with foreign space agencies with operational launch capabilities in order to get their satellites into space more speedily.

Today, the commercialization of space still focuses largely on these four activity areas. However, other policy initiatives elsewhere in the federal government coupled with the dynamic nature of the funding, management, and implementation of NASA's CUS program have expanded the scope of space commercialization. These initiatives include the parallel interests and activities of NASA's Office of Space Station insofar as developing commercial company users of space station facilities, the formation of commercial space offices within the U.S. Departments of Commerce and

Transportation, and the generally growing interest in the transfer of advanced technologies developed by the federal government, including NASA, the Department of Defense, and the Federal Laboratory Consortium, to the private sector for continued development and commercialization. It is likely that the ultimate effects of these initiatives will both strengthen and multiply opportunities for private sector involvement in space related activities. It is also likely that the categories of activity (materials processing, earth and ocean observation, industrial services, and communications) will be redefined as the commercial space movement evolves in the context of broader national and international space, technology and economic development policies.

Significance of the Research

The CUS program and the multi-organizational linkages through which its implementation depends provide insight into the relationship between such linkages and program implementation for a whole host of other technology and economic development strategies underway at all levels of government in the U.S. The general case can be inferred from the particular case of the space program, in that in all instances, the goal is the deliberate and rapid development and transfer of critical knowledge and technology to the private sector for subsequent transformation into commercial products and services.

Rather than trust completely to the vagaries of the marketplace, the emphasis is on developing strong, coordinated interorganizational relationships for joint R&D leading to advances in technology, new products, and improved processes in a variety of industry areas.

Cross-sector interorganizational relationships, thus, form a fundamental strategic element of major national policies for technology and economic development. Analysis of such interorganizational relationships will, thus, contribute to our understanding of the dynamics of such relationships, how cross-sector relationships differ or are similar to interorganizational linkages within a sector, and how such relationships affect the programs, outcomes, and policy in general.

Further, interorganizational relationships provide opportunities to refine existing theories about complex formal organizations, particularly similarities and differences across sectoral, geographic, political and cultural boundaries. Refinements in organizational theory, in turn, will contribute to greater understanding about how and why formalized linkage relationships are established.

On a more practical level, the study will help NASA CUS program managers to develop and manage new types of interorganizational relationshps with new, unfamiliar companies. More responsiveness on the part of CUS program personnel will lead to successful nontraditional NASA-

industry relationships and encourage small high technology companies which are not part of the aerospace industry to take advantage of the R&D and other opportunities afforded by NASA and the space program. This means that the civilian space program and the space environment itself can ultimately become a province for greater numbers of companies, rather than the more or less exclusive domain of the large aerospace corporations.

The following chapters describe the research project and its contributions to anthropological theories about organizations, organizational linkages, and high technology economic development. Chapter Two presents a review of the theoretical literature on formal organizations and interorganizational relationships. Shortcomings in the literature are identified in the context of this research. Chapter Three describes the research design, and Chapters Four and Five present the data which resulted from the research strategy. Discussion of the findings and their implications are presented in Chapter Six.

CHAPTER TWO

REVIEW OF THE LITERATURE

Introduction

Organizations, the nature of work and behavior within them, and their interrelationships with each other and with other aspects of social, economic, and political life have been examined by scholars and practitioners from many disciplines and perspectives. Psychologists, sociologists, political scientists, as well as anthropologists, have studied organizations in order to gain a deeper understanding of their centrality and their effects on our lives. This has created not only a vast and rich literature, but also a plethora of competing perspectives, theories, and methodological approaches. The newcomer to the field finds an astonishing array of case studies, ethnographic accounts, quantitative comparisons and experimental data generated from these various perspectives and may be daunted by the task of finding a path through such challenging terrain.

This chapter reviews the major perspectives found in studies of organizations and how these perspectives have

shaped current understanding. The first sections describe the historical development of several influential schools of thought on formal organizations. Scientific management (sometimes called the "classical school"), the human relations school, the sociological school, and systems theory have all contributed significantly to our understanding of the nature of organizations and how they operate. These schools of thought have been summarized and "mapped" according to epistemological and ontological parameters by Burrell and Morgan (1979), and their scheme is presented in the following section.

The emergence of organizational, or "corporate culture," is then surveyed and discussed. Its emergence and sporadic and fragmented development are described along with current trends. Anthropological involvement in organizational culture is relatively new and has not yet contributed significantly to the perspective's development.

We then move to a consideration of theoretical perspectives underlying studies of the relationships between organizations. Here we will be most concerned with instances of formal (i.e., written contractual), recognized and sanctioned relationships, or linkages, rather than with informal relationships, such as those formed by more fluid social networks and interlocking directorates. This is not to say that informal relationships have no effects on interorganizational relationships. Rather, our concern

reflects the fact that the great majority of government-industry linkages currently being created for technology and economic development are formalized, contractual relationships.

The chapter concludes with a discussion of the influences of organizational culture on interorganizational linkages. Works by Sayles and Chandler (1971) and Shrum (1982) provide a basis for further investigation into the factors which determine successful linkages. This discussion leads to the assumptions and analytical approach for the present study which are developed in Chapter Three.

Traditional Paradigms in the Study of Organizations

Several distinct paradigms underlie the writings about organizations. As used in this research, "paradigm" refers to an underlying set of interrelated assumptions that generates theoretical models and appropriately defined questions. The paradigms most often referenced in the literature on organizations are scientific management, the sociological school, the behaviorist, or human relations school, and some lesser known perspectives. Each of these paradigms, will be briefly described and their contributions and shortcomings examined. Additionally, another, more comprehensive view of paradigms developed by Burrell and Morgan (1979) will be discussed.

The earliest perspective on organizations grew out of practical concerns about production processes in industrial organizations and was first given recognizable form by F. W. Taylor in his 1911 publication of The Principles of Scientific Management. It has since become known as the "classical" school of management, or sometimes as "Taylorism."

Taylor's treatise oulines the basis for what he considered to be a more sensible way of managing workers and controlling productivity. In essence, Taylor felt that managers should have a sound knowledge of the multitude of discrete activities involved in all phases of production work. Once the most elemental activities, including hand and body movements, are known, work procedures for individual workers can be standardized and more accurate information about production levels obtained. The ensuing time-and-motion studies generated efficiency guidelines for greater productivity as well as empirical data for managerial decision-making. Taylor's work was instrumental in reorienting managerial behaviors away from coercion and force toward more realistic assessments of worker productivity within a particular assembly environment (Burrell and Morgan 1979). His model enabled managers to measure discrete elements of the production process as well as worker output. The paradigm that emerged from Taylor's pioneering work contributed to the view of industrial

organizations and their operations and processes as rational (in the Weberian sense) social constructs.

While elements of the classical school are still present today in approaches such as "management by objectives" (see, for example, a critique by French and Hollmann 1983) and in contemporary ergonomics, it was generally denounced as a dehumanizing perspective by critics during the 1940s and 1950s. "Taylorism" is now synonymous with rigid schedules, efficiency experts, workers-as-automatons, and labor union causes.

Several new paradigms began to develop in the 1940s, as a result of the now famous Hawthorne studies. Two of these paradigms are the "human relations" school dominated primarily by behavioral science and the "sociological" school represented in the U.S. by the "Harvard School," Barnard, Warner, Selznick, and others. Both paradigms counteracted to a greater or lesser extent the perceived excesses of Taylorism. Although other more recent scientific studies have had great impact (see for example, Woodward 1958), the Hawthorne studies conducted by Mayo, Warner, and others (Roethlisberger and Dickson 1939) were pivotal in the development of these two separate paradigms and associated applications.

Conducted at the Hawthorne plant of the Western Electric Co., the studies were designed to analyze the effects of physical elements such as lighting on worker

productivity. Surprisingly, and somewhat ironically, the findings indicated that informal groups and peer pressure within the factory (as well as the fact that someone was paying attention to the workers--the "Hawthorne Effect") were more important determinants of productivity than was the physical environment in which the work was conducted. Although subsequent analyses of the Hawthorne studies have resulted in several methodological criticisms and varying interpretations (Burrell and Morgan 1979) the studies themselves stimulated both behavioral and social scientists to examine organizations in new ways. In fact, Burrell and Morgan assert that the major contribution of the Hawthorne studies was the use of a formative version of contemporary system theory, rather than the published results and conclusions (1979: 130-142).

Among behaviorists, most notably the industrial psychologists, the studies led to systematic explorations of the characteristics of workers and job satisfaction as they relate to productivity. The "human relations school," as this approach is now known, focuses on individual workers and their adaptations to the organization. As a paradigm, the human relations school reflects the behavioral science focus on the individual, with special emphasis on personality variables, attitudes and role formation. Organizations are defined as aggregations of individuals, each bringing emotional and personality characteristics into

a group setting, so that roles develop according to personality variables and organizational demands.

This perspective has generated a wealth of studies of worker behavior and organizational dynamics and has provided a basis for applications, such as the contemporary field of organization development. Early organization development consultants focused on developing effective leadership styles for managers by advocating a preferred managerial "personality" (Blake and Mouton 1964). Others focused on integrating the individual with the group (Argyris 1957) and on small group dynamics (Argyris 1964, Beckhard 1983a). More recent organization development strategies include confrontation meetings (Beckhard 1983b, Walton 1983a), process consultation (Schein 1969), quality of working life efforts (Walton 1983b), and participation management strategies (Dowling 1983). Virtually all of these approaches stress human personality and attitudinal characteristics as important determinants of organizational productivity.

Of these application techniques and goals, participation management has probably received the most attention by scholars, practitioners and the general public. It is an intrinsically appealing strategy based on the assumption that job satisfaction and organizational productivity are directly related. Participation management is seen as a major component of job satisfaction, since

workers themselves help to make managerial decisions and so have a real "stake" in the outcomes (Dowling 1983, Likert 1967). Thus, many organization development consultants have devised strategies through which organizational behavior can be transformed from "top-down" hierarchical decision-making processes to more democratic and nonhierarchical decision-making processes. Unfortunately, as Whyte points out, the body of research on which participatory management was and is based is, in fact, inconclusive with regard to its actual effectiveness (1978: 132-133).

Despite these concerns there is still much contemporary research into the interface between the individual and the organization. For example, Kanter (1977, 1980) continues to examine the coping strategies of individuals and how people are influenced by the organizational roles they must assume. Organization development consultants also continue to inculcate more "humane" perceptions among managers and workers. In addition, human factors research is a well established focus of researchers in emerging industries, such as the space program. Research in this arena is targeted toward human interactions in environmentally harsh conditions such as those expected to occur with long-term habitation of the space station, the moon, and spacecraft for the proposed international mission to Mars (Bluth 1982 and 1984).

The human relations school is not without its critics (see, for example, Whyte 1978). One shortcoming is the failure to identify characteristics other than and in addition to personality as important human and organizational elements. As Whyte states, "[t]his line of research . . . involved the study of interpersonal relations in a structural and technological vacuum" (1978: 133). Interrelationships among phenomena within the organization, including power and decision-making processes, communication processes, informal groups, wages, and production technology as well as the interrelationships between the organizaion and a wider context are not utilized fully in the behavioral approach. This is not surprising given the paradigmatic underpinnings of industrial psychology with the focus on similarities and differences among individuals.

Arensberg (1978) is one of the few nonbehaviorist scholars to utilize the individual as the unit of analysis. His work, however, has been carried out from the standpoint that interactions among individual persons result in network patterns that are, in turn, building blocks to more complex social structures. Thus, the problem with the human relations paradigm is not so much that the focus is on the individual, but that the behavior of individuals is not systematically aggregated into patterns within richer contextual settings.

Another major paradigm which emerged out of the Hawthorne studies has come to be known as the "sociological" school. While it shares a common heritage with the human relations school, attention shifted to the structural aspects of formal organizations. Individuals within the organization are not ignored, but their behavior is thought to reflect more than personality characteristics. For the sociological school, organizational behavior is part of the wider social, political, and economic context.

Thus, Barnard (1938) asserted that cooperative relationships among individuals within the organization were fundamental to meeting organizational goals, Simon (1957) developed the concept of the 'bounded rationality' of individuals within rational organizations, and Selznick (1948) saw the organization as both an economy and an adaptive social structure. These and later scholars were influenced also by the functionalist models of Malinowski (1922) and the more completely developed structural-functionalism of Radcliffe-Brown (1952). Further, the translation of Weber's (1947) The Theory of Social and Economic Organization in 1964 provided additional support for the study of the structural characteristics of organizations, and particularly of bureaucratic forms of organization.

Several specific theoretical models and methodological approaches were subsequently developed by anthropologists and sociologists within this general paradigm. These included the interactionist models of Chapple (1953) and Arensberg (1972), community and organization studies (Warner and Low 1947), and models of formal and informal structures within organization (Selznick 1943, 1948).

The sociological paradigm also led to attempts to develop typologies for classifying organizations according to models developed by Weber (1947) and others (see, for example, Brown 1974 and Pugh, Hickson, Hinings and Turner 1968). These classification schemes stress the rationality of organizations, that is, the view that organizations are consciously structured to control processes necessary for the accomplishment of predetermined tasks. The schemes also rely heavily on such overt organizational characteristics as size, composition of work groups, span of control and so forth.

Thus, two distinct but somewhat interrelated paradigms emerged from the Hawthorne studies. On one hand, the behaviorists were dominated by basic assumptions about the nature of the individual, and the individual was and is the unit of analysis. On the other hand, the sociological paradigm has generated works using the organization itself and/or sub-grouping within it as the units of analysis. Individuals as culture-bearing members of an organization

are studied by sociologists insofar as they comprise conflicting and adapting social formations within the context of organizational boundaries.

Each of these three broad paradigms, the managerial, the behavioral, and the structural generated a variety of specific analytical foci and reflected the broader traditions of theory development and scientific methods of the social and behavioral sciences. Also, many hybrid approaches emerged from attempts to integrate aspects of the behavioral and the sociological paradigms.

One such approach is sociotechnical systems theory as utilized by the Tavistock Institute (Klein 1976, Burrell and Morgan 1979: 146-148). Sociotechnical approaches generally focus on the interaction between individuals and the technical systems of production within organizations. In many studies, the technical portion of the system is assumed to be relatively static, as in the case of factory assembly lines and equipment. The goal of such studies is to examine the methods by which the individuals within the organization adapt to the technology (Emery 1966 and 1982, Pasmore, Francis, Haldeman, and Shani 1982, Trist 1974). Other studies incorporate more dynamic models of technical systems and focus on interrelationships between people and changing technical systems in settings other than manufacturing plants (Ciborra, Migliarese, and Romano 1984,

Hirschhorn 1984, Ketchum 1984, Kolodny and Kiggundu 1980, Cherns 1976).

During the 1950s, however, the differences between the classical, behavioral, and sociological paradigms became blurred with the refinement of systems theory within the social sciences. As Burrell and Morgan (1979) indicate, however, the systems perspective was emergent in the Hawthorne studies, and organization scholars in all three traditions found no difficulty in adopting elements of system theory into their own paradigms. For example, classical scholars became concerned with "production systems," while behaviorists tended to focus on various subsystems, such as the Katz and Kahn (1978) model of technical, supportive, maintenance, adaptive, and managerial subsystems within the organization. The sociotechnical systems approach has already been mentioned as a hybrid between sociological and behavioral approaches.

Social scientists have recently developed contingency theory, in an attempt to accommodate the various effects of differing "environmental inputs" on organizational subsystems as well as on the organizational system as a whole (Beckhard 1983c, Burrell and Morgan 1979, Pfeffer and Salancik 1978, Lawrence and Lorsch 1967). Other theorists have modeled organizations from the basis of one dominant subsystem, such as power or political subsystems (Gamson 1981) and resource dependency (Pfeffer and Salancik 1978).

Still others have focused on equilibrium or conflict as primary system characteristics (Benson 1977, Merton 1968).

While it is true that the systems "revolution" increased awareness about the complexities of organizatonal structures and their interrelationships among each other and with the environment, community, or other defined context, systems theory has proved to be too vague for many useful syntheses. For one thing, early systems models grew out of the structural-functionalist orientations of early social theorists, and consequently were originally formulated as static entities. Organization systems were viewed either too simplistically, as in the "organization-as-black-box" models which characterize simple input-throughput-output processes, or in too much conflicting detail, as presented by the extraordinarily wide range of analytical studies on various subsystems. In addition, with few means for analyzing change processes (system dynamics), except through retroactive inference, many systems models fell back into more traditional descriptions and analyses of structural components.

Work continues in the systems framework, however, with attempts to categorize different types of systems according to change processes (Rosengren 1982), to illustrate system-environment "misfits" (Fry and Berkes 1983, Applebaum 1982), and to identify primary characteristics or processes from which to model organizational systems (Jones 1983, Arensberg

1978, Whyte 1978). But despite these more recent attempts, and despite important new insights into the relationships between component parts and processes and between the organization and its wider human cultural context, comprehensive modeling allowing for predictability is still beyond reach.

An Alternate Model of Paradigms for the Study of Organizations

The previous section highlighted the approaches to research on organizations that are commonly presented in historical overviews of the field (Holzberg and Giovannini 1981, Arensberg 1978, Whyte 1978, Gardner 1977). They are often treated as paradigms because they incorporate different assumptions, approaches, and analytical foci.

However, another formulation of paradigms and organizational theories has recently been developed by Burrell and Morgan (1979). In this comprehensive work, Burrell and Morgan present paradigms as emerging from more fundamental underlying assumptions about the nature of science and the nature of society.

Views of the nature of society are arranged along a continuum with regulation (steady-state) and radical change at the two extremes. The nature of social science depends upon a combination of assumptions about reality, epistemology, human nature, and methodology, and is

presented on another continuum between the extremes of subjectivism and objectivism. When the two continua are arrayed, one vertically and the other horizontally, four quadrants appear which define the paradigms presented in the book: functionalism, radical structuralism, radical humanism, and interpretive sociology. Theoretical schools are than arranged spatially within the appropriate quadrants.

From this perspective, the previously discussed paradigmatic approaches take on a much different appearance. In fact, they cease to be 'paradigms' at all. Even more illuminating is the fact that through this portrayal, the differences in perspective and focus previously described are outweighed by more fundamental similarities of assumptions about the nature of society and social science.

Burrell and Morgan (1979) justify this paradigmatic view in the following manner:

> We regard our four paradigms as being defined by very basic meta-theoretical assumptions which underwrite the frame of reference, mode of theorising and modus operandi of the social theorists who operate within them. It is a term which is intended to emphasise the commonality of perspective which binds the work of a group of theorists together in such a way that they can be usefully regarded as approaching social theory within the bounds of the same problematic. . . . The 'unity' of the paradigm thus derives from reference to alternative views of reality which lie outside its boundaries and which may not necessarily even be recognised as existing. . . . To be located in a particular paradigm is to view the world in a particular way. (1979: 23-24)

The authors go on to note that although there may be considerable activity and changing allegiance within a paradigm, journeys between paradigms are quite rare. In addition, they have designed their paradigms to be mutually exclusive, "in the sense that one cannot operate in more than one paradigm at any given time, since in accepting the assumptions of one, we defy the assumptions of all the others" (1979: 25).

In brief, the functionalist paradigm

> seeks to provide essentially rational explanations of social affairs. It is a perspective which is highly pragmatic in orientation, concerned to understand society in a way which generates knowledge which can be put to use. It is often problem-orientated [sic] in approach, concerned to provide practical solutions to practical problems. It is usually firmly committed to a philosophy of social engineering as a basis of social change and emphasises the importance of understanding order, equilibrium and stability in society and the way in which these can be maintained. It is concerned with the effective 'regulation' and control of social affairs. (Burrell and Morgan 1979: 26)

Burrell and Morgan (1979) state that the functionalist approach is based on the assumption that society can be examined and measured by natural science techniques because it is composed of concrete and empirical elements and relationships. They point out that most functionalist models of the world utilize mechanical or biological analogies.

In this scheme, the classical, behavioral, sociological, and systems perspectives are all located within the functionalist paradigm. According to Burrell and

Morgan (1979), all of these perspectives are based on fundamental assumptions about the inherent stability of societies and an objective approach to social science (nomothetic methodology, positivist epistemology, deterministic human nature, and an ontology based on realism).

A second paradigm, interpretive sociology, shares with functionalism the assumption of inherently stable social formations, but it differs from functionalism in the assumptions held by its adherents about the nature of social science. Here, advocates take the view that social science is a largely subjective enterprise. Social science is or should be nominalist, anti-positivist, voluntarist, and ideographic. In short, interpretive theorists (including phenomenologists, symbolic interactionists, and ethnomethodologists)

> see the world as an emergent social process, which is created by the individuals concerned. Social reality insofar as it is recognised to have any existence outside the consciousness of any single individual, is regarded as being little more than a network of assumptions and intersubjectively shared meanings. (1979: 28-31)

The radical structuralist paradigm is similar to the functionalist views of social science, but concentrates on conflict, contradiction, and domination as basic attributes of social forms. Radical structuralists are generally committed to massive amounts of change concentrating on the domain of structural relationships. Theorists within this

paradigm share "the view that contemporary society is characterised by fundamental conflicts which generate radical change through political and economic crises" (1979: 34). The later works of Marx, as well as those of scholars concerned with the structure of power relationships form the bulk of analytical models within this paradigm. Burrell and Morgan (1979) also place within this paradigm theorists who have developed conflict theory. Benson (1977) provides a good example of an organization theorist who would fit well within this paradigm.

Radical humanism, the fourth paradigm, is distinguished by the attempts of its adherents

> to develop a sociology of radical change from a subjectivist standpoint . . . its frame of reference is committed to a view of society which emphasises the importance of overthrowing or transcending the limitations of existing social arrangements. . . . It is a brand of theorising designed to provide a critique of the status quo. (1979: 32, italics in the original)

Among the theoretical schools represented here are French existentialism, critical theory, and anarchistic individualism, many of which draw upon the early writings of Marx. When applied to organizational research, Burrell and Morgan (1979) assert that anti-organizational theories have recently begun to emerge through a few writings and case studies, such as Reich's (1972) The Greening of America and Gouldner's (1972) The Dialectic of Ideology and Technology.

This view of paradigms provides insights into the interrelationships among functionalist theories and the contrasts between them and radically different approaches not readily discernible in the literature on organizations. Although it is certain that not all theorists would agree on the placements of various schools within the four paradigms, there do not appear to be specific critiques in this vein.

According to the Burrell and Morgan scheme (1979), however, no new paradigms can develop. In their model, the only remaining activities are those directed either toward refining existing theoretical approaches within the paradigms or forging new theoretical directions within the less developed paradigms. However elegant the framework, it may be insufficient to portray adequately the complexities of and interrelationships between the dynamic theoretical perspectives on organizations. Expansion of the present two-dimensional matrix into a three-dimensional framework may be more appropriate, albeit more difficult to depict and use.

A possible third dimension could incorporate the notion of time. One end of the continuum would thus reflect concepts of "timelessness," as embodied in synchronic orientations to science and society. The other end would represent "timeliness," that is, views derived from diachronic orientations to science and society. Thus on one hand are concerns about static comparisons, status quo,

structural characteristics, and classification schemes based on a concept of "frozen" time, and on the other hand are concerns about process, history, evolutionary and radical change, relativity, and dynamic interpretive processes. In fact, it appears that such a dimension is already emergent in the dichotomy drawn between the two ends of the societal parameter (status-quo and change) as well as in the dichotomy represented by subjective versus objective views of science.

In any case, the Burrell and Morgan (1979) scheme provides an excellent exploration into the relations between organization theory and the larger world of social theoretical thought. It is a useful contribution to the understanding of organizations as human cultural phenomena as well as to the theoretical approaches inherent in their study.

Corporate Culture

Leaving the Burrell and Morgan framework aside for a moment, organizational studies appear to have taken a new direction. This new direction can be called the "culture and organization school" in its broadest form, but it is generally known as "organizational, or corporate culture." This view of organizations has emerged for a number of different reasons, but the most visible stimulus has been

growing dissatisfaction with more traditional approaches to the study of organizations, organizational change, and interorganizational relations. Increasing numbers of researchers have turned away from behavioralist approaches associated with industrial psychology toward the concept of culture for analysis and modeling.

Unfortunately, however, the concept of corporate, or organizational culture is not yet fully or satisfactorily articulated. There are several reasons for this. First, the concept first gained popularity with business and industrial executives through the writings of management consultants and others trained in behavioralist traditions. Consequently, the definitions of "culture" communicated to managers and utilized in a variety of activities and settings are often merely 'new packaging' of traditional behavioralist assumptions about the individual and the group. Second, anthropologists have not generally or publicly associated themselves with the 'organizational culture' approach. This may be due to the fact that most anthropologists view their studies of organizations as already emerging from examinations of broader cultural themes.

The absence of an 'anthropological presence' in basic and applied research in organizational culture has created two effects. One is that few managers, executives, consultants, or other professionals active in organizational

consulting and decision-making are aware of the richness and utility of specifically anthropological perspectives inherent in the concept of culture for understanding organizations. The second effect is the fact that both the legitimacy and power of "culture" as a heuristic device are now constrained and subject to the faddish whims of nonanthropologically trained management consultants, organization development practitioners, and organizational decision-makers themselves.

Third, recent anthropological and sociological explorations of the concept of organizational culture incorporate the various and competing assumptions and approaches that characterize scholarly discourse on the concept of culture in general. This means that definitions and operationalizations are disjointed to a degree that precludes identification of a common distinguishing theme. Thus, anthropological contributions to this emerging paradigm in the study of organizations remain generally unrecognized and lack credibility for managers, executives, and consultants.

The emergence of corporate culture as a recognized, if incoherent, approach to organizational research and applications was signalled by the publication by two management consultants of Corporate Culture (Deal and Kennedy 1982). Although their definition of culture differs from many traditional anthropological formulations, the book

established "corporate culture" as a 'new' approach for managers, consultants, and the public.

Deal and Kennedy (1982) define culture as the business environment, values, heroes, rites and rituals, and a cultural (communication) network. Their basic assumption is that culture is the most powerful determinant of behavior. Thus, it is closely related to worker integration within the organization and to productivity. They further assert that "culture shock" is the primary reason for individual failure in a new company or organization, and that company success depends upon how well the corporate culture is managed. They consequently construct a typology of corporate cultures based on degree of risk and on the speed of feedback about individual or organizational successes and/or failure. Nelson (1983) sums up the anthropological critiques of the work when he targets the authors' concepts of "weak vs. strong" cultures and superficial treatment of the concept of culture. He does, however, conclude that anthropologists should conduct research on corporate culture. The popularity of Deal and Kennedy's (1982) Corporate Culture and other works (see for example Peters and Waterman 1982) among business executives, managers, administrators, consultants, and the general public reveals widespread interest in alternative ways of understanding the nature of organizations, how they work, and what they do.

Unfortunately, while anthropologists and other social scientists have long utilized cultural models and ethnographic research methods to study formal organization, their contributions to organizational research and theory are unknown to managers, consultants, and the public. With the exception of the early sociological approaches to organization discussed earlier in this chapter, the most widely acknowledged approaches to organizational research and applications are still those of behavioral science. Consequently, many works on organizational culture have a definite behaviorist flavor.

One reason for this is that behavioral scientists entered the workplace as well as the faculties of business colleges, while anthropologists and other social scientists more often chose faculty positions in academic anthropology and sociology departments (Ouchi and Wilkins 1985). Thus, behavioral science perspectives still dominate the education of business school graduates who subsequently become company decision-makers and shape their organizations and their organizations' activities.

A second reason for this is that much anthropological research carried out within organizational settings has been concerned with evaluating programs through which broader social policy has been implemented. Thus, these researchers have not specifically treated organizations as the objects of research. Rather, they have considered organizations

insofar as they have affected and been affected by the particular program being evaluated. Nevertheless, such research has shed light on facets of organizational life of interest to theorists (see, for example, Rossi and Freeman 1985, Day 1980, Britan 1979, Stephens and Agar 1979, Pressman and Wildavsky 1979).

Further, those anthropologists who are employed in non-academic settings tend to publish fewer articles in both mainstream academic publications and industry 'trade' journals. Thus, despite some notable exceptions (Ouchi and Wilkins 1985, Frost, Moore, Louis, Lundberg, and Martin 1985) anthropological perspectives on organizational culture are not widely disseminated within the discipline or outside it.

However, since the late 1970's anthropological investigations into formal organizations, particularly bureaucracies and business and industrial organizations, have increased after a general hiatus. Some might argue that anthropological interest in the study of formal organization has never ceased, however reviews of the literature in anthropology do not yield sustained, systematic investigations into organizations per se. Rather, the literature illustrates concentrations of scholarly activity within the domains of evaluation research, agricultural and industrial development in the third world, health care and health delivery systems, and

gender. Again, formal organizations (notably bureaucratic forms of organization) are research subjects insofar as they interact with program delivery in the aforementioned topical domains.

As noted above, those anthropologists who have begun to explore organizational culture and to apply the concept to organizations utilize theoretical perspectives related to the study of culture in general. For example, a number of researchers utilize a 'microcultural' approach (Ouchi and Wilkins 1985) to examine organizations as cultures themselves. Others take a 'macrocultural' perspective and view organizations as bounded settings in which the cultural attributes of a society or the relationships between the organization and the larger sociocultural environment can be studied (Louis 1985, Apter and Goodman 1976). Cross-cutting these orientations, culture is alternatively an independent variable and a dependent variable (Ouchi and Wilkins 1985). Such differing perspectives confuse the issue and constrain efforts to develop comprehensive analytical models, just as they do in theorizing about culture in general.

Usually organizational culture is the dependent variable. Examples include examinations of the organization's enculturation/socialization processes (Jones 1983, Kanter 1980, Regoli, Poole, and Schrink 1979, Sieber 1979), resource allocation (Pfeffer and Salancik 1978), meanings and values as expressions of organizational culture

(Smircich 1985, Bate 1984), and organizational subcultures (Van Maanen and Barley 1985). Britan (1979b) discusses the problems of doing fieldwork in a bureaucracy, implying that a bureaucratic organization can be treated as a field site just as a tribal village is considered a field site, Cornfield and Sullivan (1983) discuss the problems of doing fieldwork within corporate oligopolies, and Kanter (1977) has produced an "ethnography" (her term) of the Indsco Corporation. Finally, Dubinskas (1985) compares scientists and managers, two culturally distinct groups, and the subsequent formation of two independent hierarchies within the same organization.

Other studies view organizations as part of larger cultural systems. While this is axiomatic for anthropologists, few scholars and practitioners outside anthropology acknowledged it until Lawrence and Lorsch (1967) "discovered" the environment. Management theorists, consultants, and other nonanthropologically trained researchers rarely thought of organizations as anything but closed systems.

Realization of the importance of the larger cultural context, or 'environment,' of organizations also was not widely acknowledged outside anthropology before the maturation of two recent economic trends. One trend is the growing presence of American corporations in foreign countries and their dependence on local people as workers.

This forces American managers in foreign settings to learn about the characteristics of the host culture that affect organizational operations and social relations. Ricks (1983) has explored the nature of blunders made by American companies in foreign markets to illustrate the necessity of understanding other cultures.

The other, more recent trend is the growing dominance of Japanese and European companies in world markets and the simultaneous decline of U.S. economic competitiveness. This has generated concern about American attitudes and practices with respect to company operations, management practices, educational level of workers, and other internal activities and processes. Do the Japanese really do it better? Should U.S. companies adopt different organizing, production, and operations procedures modeled after those of Europe? Suddenly, the nature and character of other cultures, as well as the dynamic nature of international financial, governmental, regulatory, and other domains has moved into prominance.

There are now several focal areas in studies of formal organization as part of larger cultural systems. These include examinations of the nature of cultural attributes brought to organizations and their effects within the organizational setting, as well as studies concerned with the interaction between the formal organization and the larger cultural context. Examples of the first focal area

include Atsumi's (1979) exploration of how the ritualized Japanese relationship of "tsukiai" operates in the workplace, Deyo's (1980) findings that friendship bonds between women formed prior to and outside their work in a Singapore factory were more important determinants of support in the workplace, and Wolff's (1977) findings that the lower status of women in the workplace reflected their lower status in society in general. Hobart (1982) explores the problems of socializing native peoples to industrial work settings, Dreher (1983) demonstrates that organizations can reflect the larger culture in her analysis of ganja smoking in the work environment of a Jamaican sugar plantation, and Badaway (1980) concludes that managers favor mechanisms that mirror traditional cultural values.

Other researchers focus on processual and/or structural relationships between organizations and their wider socio-cultural context. Thus Byron (1980) compares two attempts to change organizational technology and operations among Shetland fishing crews. One attempt at technological innovation failed because there were no equivalencies between the Norwegian culturally-based new system and the existing Shetland situation. The other innovation attempt succeeded because the new technological system was designed and implemented along the lines of traditional crew structure. Doreian and Hummon (1980) conclude that the movement between government, academic, and industrial

organizations of American scientists and engineers depends primarily on the nature and structure of rewards systems rather than on intrinsic satisfaction and interest in particular scientific problems. Taylor and Bogdan (1980) explore the need for congruence between organizational symbols and public perceptions of those symbols for organizational success, and Abouzeid (1982) reports that U.S. corporations have legitimized and institutionalized social responsibility as a primary element of strategic planning and operations. Related studies include examinations of the cultural determinants of organizational hierarchies (Britan and Cohen 1979) and conflict within organizations and between organizations and a community (Gricar and Brown 1983, Benson 1977).

Diebold (1982), in a series of addresses, shows how U.S. business and industrial organizations must conform and adapt to broad and changing political, social, and economic demands. Fry and Berkes (1983) demonstrate how the traditionally bureaucratic "paramilitary" organizational structure of police organizations in the U.S. contradicts and interferes with their actual technology, goals, operations, and contexts. Zucker (1983) on the other hand maintains that most perspectives on organizations emphasize their reactive and adaptive characteristics in larger social contexts, but that a more useful perspective is a focus on how organizations act as institutions and shape common

understandings of individuals within the broader society. Finally, Singer (1980) explores problems of societal and organizational "misfits," or "crazy systems," Blankenship (1977) explores the nature of professionalism, and Burawoy (1979) offers a synthsis and critique of work from an anthropological perspective.

In related studies, organizational adaptation to changing cultural conditions are currently being explored. These adaptations contrast to more narrowly defined and deliberate change agents, such as take-overs or "spinoffs" of small companies from larger ones. One notable study of the interrelationships between organizations and culture in a change situation is Rosengren's (1984) cross-cultural comparison of structural adaptations made by administrators of British and Spanish nautical schools in response to political and economic reorganizations in those countries. Applebaum (1982) has also explored organizational change in his study of the bureaucratization of the construction industry according to contemporary changes in American society. He contrasts organizational needs with cultural and environmental demands arising from major ideological shifts in American culture with respect to craftsmanship, independence, small group behavior, networks, and definitions of success.

Thus, works on organizational culture include not only the traditional interests and approaches of anthropology,

but also many nonanthropological studies and writings. It is difficult to group these works and regard them as representing a "paradigm," however, because of the tremendous diversity of assumptions, questions, approaches, and research techniques. It would not be considered a paradigm at all on the basis of the Burrell and Morgan (1979) scheme. In fact, the particular strains of thinking found within organizational culture writings could be placed spatially in all four paradigms, depending upon the foci, methods, and assumptions about the nature of culture, organizations, and social science.

If one considers organizational culture to be at least an emergent paradigm, then it can be viewed as a natural outgrowth of the three earlier paradigms and systems models. These include such things as the dynamics of interpersonal interaction among organization members, socialization of individuals into the organization, the symbolic nature of organizational goals and activities, the structure and activities of organizations as open systems, and the characteristics that define one organization as being "different" from all others. The concept of organizational culture offers something for everyone, but not everyone agrees about which aspects are most useful for integrating the entire "paradigm."

There is much disagreement about the utility of organizational culture as a better way to study, analyze and understand organizations. Smircich (1985), for example, maintains that the concept has not significantly increased comprehension. She asserts that increased understanding will result only when organizational culture is modeled after culture as a symbolic system so that organizations are viewed as displays of shared meanings and values. Similarly, Louis (1985) asserts that definitions and implicit assumptions about organizational culture are not well articulated and are permeated with faulty and contradictory reasoning.

Van Maanen and Barley (1985) argue that the concept of organization-as-culture is inappropriate when one focuses the analysis on the organization itself. Implicit in their argument is the alternative usage of the concept of culture as either a dependent or an independent variable as pointed out by Ouchi and Wilkins (1985). Van Maanen and Barley (1985) as well as Louis (1985) assert that the overall cultural consistency is lost because culture is located and continuously emergent in work settings within the larger organization; that is, it is the dependent variable rather than an independent variable. The continuously emergent nature of culture as symbolic process, according to the authors, is fundamental to organizational dynamics and structure. Unfortunately, works emanating from symbolic

perspectives indicate as great a difficulty in defining organizational culture as symbolic anthropologists encounter in defining culture in general.

If differing conceptualizations of the concept of organizational culture mirror diverse approaches to culture in general, it may be that the concept of organizational culture is a more useful heuristic device when organizations are studied in relation to each other and to their wider cultural context. Using this perspective, a variety of useful questions emerge: How and why do organizations deliberately link with one another? Do differences between organizational cultures preclude or enhance interorganizational linkages? Are some elements of organizational culture more important in determining successful linkage creation, maintenance and outcomes? To what extent do organizations reflect dominant themes of the wider culture of which they are part? Organizational culture may, in fact, provide additional insight into these questions. In the following section we turn to a brief discussion of the research to date on interorganizational relationships to see whether the concept of organizational culture may be a useful analytical tool.

Interorganizational Relationships

Interorganizational relationships were not widely studied before open systems models were developed in the

1960s. The open systems models acknowledged that organizations were in constant interaction with their 'environments,' including other organizations (Lawrence and Lorsch 1967). The literature on interorganizational relationships is thus not as extensive as that on organizations per se, but it reflects the same wide range of approach as the literature on organizations.

The vast majority of studies have focused on resource exchange as the means by which organizations link with each other to achieve a variety of ends. "Resources" are variably defined. They include capital, labor, expertise, technologies, equipment, facilities, raw materials and components, or more abstract commodities, like prestige, legitimacy and power. In all cases, however, resources exchanged are those deemed necessary for continued organizational viability.

Two dominant schools of sociological thought, the "collectivistic" and the "individualistic," underly exchange theories (Ekeh 1974 after Parsons 1961). Collectivistic exchange theories derive largely from the collectivistic views of the French sociologists, particularly Durkheim and Levi-Strauss. Individualistic exchange theories, according to Ekeh (1974) derive primarily from Frazer and Homans. According to Ekeh (1974: 6) the polemical interplay between the collectivistic and individualistic traditions has generated much of the vigor

of sociological and anthropological theory in the 20th century.

With regard to exchange, collectivist orientations focus on patterns of exchange present among social formations within a society. Both social and resource exchange are viewed as representations of and mechanisms for the particular formal structures of a society. Arising from early studies of kinship, particularly marriage exchange, collectivist exchange theories seek to reveal structural characteristics of societies in general.

Individualistic orientations to exchange stress exchange relationships among pairs of individuals. Society is not viewed as a 'whole' in the Durkheimian sense, but as the sum of its individual members and their activities. Thus, Ekeh (1974) agrees with Piaget's (1968) distinction between structures (or collectivities) and simple aggregates of individuals. Individualistic exchange theories focus on exchange relationships among individuals in an effort to elucidate the formation of aggregates (see also F. A. Hayek 1973).

The literature on interorganizational linkages reflects both collectivistic and individualistic theories and assumptions, but the most common perspective tends toward the collectivistic. A large body of literature is devoted to the structural characteristics of linkages among collectivities. These studies elucidate the structural

parameters affecting and affected by habitual exchange relationships between and among collectivities. In this vein, many of the early studies of organizational relationships focused on defining the forms and contexts of the linkages.

In one of the earliest works on interorganizational relationships, Levine and White (1961) and, later, White, Levine and Vlasak (1971) utilized resource exchange perspectives to describe the contextual domain of interorganizational linkages within the health care industry. A fundamental concept in their work was that of the "domain," which they defined as the organization's specific goals and operations. Domain consensus, or the agreement of other organizations within the domain as to one another's goals and operations, is viewed as the prerequisite for exchange relationships between organizations (Levine and White 1961: 597).

Similarly, Thompson (1962) defines the 'transaction structure' in which four types of transactions occur between organizations, Evan (1965) develops the 'organization set' to define parameters for further structural analysis, Litwak and Hylton (1962) examine the functions of coordinating agencies, and Warren (1967) explores the 'environmental field' in which organizational linkages occur and the extent to which it is itself organized. In a slightly different vein, Wren (1967) concentrates on linkage processes and

outcomes in his comparison of the aerospace industry and the more loosely linked utilities companies and their abilities to mobilize people and resources to meet objectives and cope with emergencies. Aiken and Hage (1968), operating from an exchange perspective, studied a number of joint programs and the internal structures of sixteen health and welfare organizations and developed a series of testable hypotheses whereby organizations' structural and procedural complexities are related to their tendencies for entering into joint programs.

In the 1970's interest in interorganizational linkages grew substantially. While exchange perspectives continued to dominate the literature, other orientations began to appear. For example, Thompson (1970), summarized a group of papers presented at a conference devoted to interorganizational relations in the health care industry at Johns Hopkins University. He noted the appearance of several new interests and foci appearing in studies of interorganizational relationships, including organizational redundancy, the creation and distribution of power, the effects of time, and managing linkage environments.

In a recent overview of the theoretical work on interorganizational relationships, Galaskiewicz (1985) has highlighted main currents in the literature. However, it appears that all of the perspectives he discusses assume that resource exchange is the primary mechanism for

achieving overt and covert organizational goals. These goals include securing necessary resources for internal operations, obtaining and maintaining power to control uncertainties or to advocate policy, and increasing organizational legitimacy. Resource acquisition and exchange are assumed to be the means by which interorganizational linkages are formed and maintained. This assumption underlies virtually all studies of interorganizational relationships regardless of focus. Thus, Galaskiewicz (1985) focuses on the purposes of interorganizational linkages with some considerations as to their form and operations. The implicit view is that organizations as open systems utilize strategic resource exchange to maintain existence over long periods of time.

Galaskiewicz (1985) notes that exchange theories of interorganizational linkages were fueled by the popularity of more general theories of resource dependency. He points out the importance of power, in the form of resource dependency, on theories about interorganizational relations (1985: 283). Drawing largely from Emerson (1962), a body of literature emerged during the 1970s which explored interorganizational linkages from the perspective of dependency relationships both between organizations and between organizations and communities. A major theme for these studies was and is the relative power of 'focal' organizations over other dependent organizations in a

network or in terms of community influence (see, for example Pfeffer and Salancik 1978 and Cook 1977).

Another area of interest, according to Galaskiewicz (1985), is resource procurement and allocation as a linkage strategy designed to exert greater control over uncertain or fluctuating organizational environments. Resource exchange is both the means and an end for linkage creation, since a stable resource base is necessary to control contextual uncertainties, that is, risk. Notable studies here include Kent's (1984) analysis of environmental effects on linkage strategies, Galaskiewicz and Shatin (1981) on the characteristics of attractive linkage partners, Aldrich's (1979 and 1982) studies of boundary spanning, Burt (1980) and Useem (1984) on interlocking directorates, and Leblebici and Salancik (1982) on the stability provided by 'interorganizational organizations.'

Related to studies of environmental uncertainties are those which focus on linkages for political action and/or advocacy. Scholars utilizing this perspective examine theoretical, ethical, and practical problems of interorganizational linkages designed to influence large scale political decisionmaking and social policy (see, for example, Benson 1975, Bok 1981, Knoke and Laumann 1982, and Galaskiewicz 1985). Again, resource exchange is viewed as both a means and an end. It is seen not only as the linkage mechanism, but also as a goal in itself since collective

power over resource acquisition and allocation is equated with political power to shape policy development. Resource exchange reduces uncertainties in policy and regulatory environments for linkage partners.

Obtaining organizational legitimacy is also a theme in studies of interorganizational linkages (Galaskiewicz 1985). Here scholars are generally concerned with understanding how organizations achieve greater legitimacy in the eyes of the public by linking with existing publically approved and sanctioned organizations. Thus, DiMaggio and Powell (1983) explore the phenomenon of isomorphism, or the tendency for organizations to become similar to other, highly acceptable and legitimate organizations within an industry over time. Their model derives largely from Weberian structural approaches and explains organizational change as resulting from four factors: degree of organizational interaction, defined patterns of interorganizational domination, increased information load, and perceived distinctive boundaries binding the actors in one field. Other studies in this arena include Pfeffer and Salancik (1978), Useem (1985), and Fry, Keim, and Meiners (1982).

This brief overview of collectivistic orientations to interorganizational relations reflects a dominant concern with resource exchange as means and ends and with elucidating broad societal structures, or collectivities, as they emerge over time. The various contexts of linkage

relationships, including market, regulatory, political, and social environments, remain a major theme for such studies. Another major theme is reflected in studies of structural changes in social formations depending on environmental constraints and fluctuations. A third theme is represented by efforts to identify and characterize the elements of interorganizational linkages in general, regardless of the nature of participating organizations, goals, and contexts.

Individualistic orientations to interorganizational linkages are much less represented in the general literature. Network theory probably best represents individualistic approaches to linkages, as scholars identify and map relationships between individuals and describe the resulting larger scale social formations, or 'aggregates.' Examples of works in this arena include Blankenship's (1977) examination of the characteristics and effects of networks of professionals which crosscut formal organizations and Vaughan's (1983) development of the concept of 'focused networks' to model interorganizational relationships that temporarily emerged in the context of investigating Revco during the 1970s. Shrum (1982) also makes use of network theory in his analysis of technical systems. Shrum defines a technical system as "a state-administered network of actors oriented toward the solution of a set of related technological problems (e.g., sending a man to the moon, curing cancer)" (1982: 7). Technical systems coordinate and

administer the diverse, but related research and applications activities carried out via networks of professionals. Individualistic perspectives that do not rely extensively on network theory are illustrated by Lefton and Rosengren's (1966) conclusions that research on interorganizational linkages should focus more directly on the clients of organizations to reveal both the lateral and longitudinal dimensions of organizational interaction.

Individualistic perspectives dominate writings by persons who are responsible for managing organizational linkages to a greater extent than they do the more academic studies and analyses. Linkage managers generally are less concerned with overall societal influences and effects vis a vis interorganizational linkages than they are with the day-to-day supervision of individuals directly involved in linkage activities. Thus, Stiffman, Feldman, Evans, and Orme (1984) describe practical ways to determine whether linkages between social service agencies and university research departments are really beneficial to the social service agency. Using a social exchange framework, the authors conclude that a practical way for managers to evaluate a potential linkage relationship involves examination of ways to minimize costs, maximize organizational rewards, and achieve reciprocity in the net outcomes accruing from interorganizational collaboration (1984: 49).

The authors then suggest practical ways in which these criteria can be met.

Numerous other writings stress linkage management from the practical manager's viewpoint. Among these are Evan's (1965) hypotheses about individual boundary spanners' decision-making in linkage contexts, Langfitt, Hackney, Fishman, and Glowasky's (1983) treatment of university-industry linkages and their concern to present, among other things, a "how-to" guide for negotiating linkages. Examples are provided, including a complete description of the Monsanto-Washington University agreement for collaborative research ventures. Additionally, Fowler (1982-83) discusses the nature and content of the research agreement between universities and industries, Brody (1985) describes linkage strategies between industrial organizations and the nation's federal laboratories, and Reams (1986) characterizes successful university-industry research partnerships.

Earlier, Marrett (1971) synthesized the work on interorganizational relationships by determining measurable indicators of their dimensions and hypothesizing likely associations between the dimensions. She cites five domains of interest in the study of interorganizational relations: intra-organizational characteristics, comparative properties, relational properties, formal contextual properties, and nonorganizational contexts. After reviewing the relevant studies, she concludes that there are four dimen-

sions for analysis: degree of formalization (both for agreements and structures), intensity of the relationship (both in resource size and frequency of interaction), reciprocity, and standardization. Her synthesis is much broader than Galaskiewicz's (1985) because of the less developed state of resource exchange and dependency models.

The literature on interorganizational relationships, as Galaskiewicz notes, "is highly fragmented, and the scholarship uneven" (1985: 281). The majority of studies cited in his review and in publications in the area are drawn primarily from the traditional domains of organization and management research. Resource exchange is generally assumed to be the driving force behind linkage creation, and network models underly many investigations into linkage patterns and structures. Both individualistic and collectivistic strains permeate the writings.

Another approach to the study of interorganizational linkages emanates from general considerations of decision making. Mulford and Rogers (1982) advocate analysis of linkage situations based on decision processes and draw upon the works of Aiken, Dewar, DiTomaso, Hage, and Zeitz (1975) and Warren, Rose, and Bergunder (1974) to develop a typology of linkages. The typology places linkage responsibilities within various levels and departments of participating organizations depending on the nature of decisions to be made. Further, Mulford and Rogers (1982) see resources as

only one of four elements that are coordinated in inter-organizational linkages. The other three elements include programs, clients or recipients of the coordinated activity(ies), and information. Mulford and Rogers (1982) maintain that the multivalency of 'resources' leads to tautological discussions among resource exchange theorists.

Other themes are also present within the literature on interorganizational linkages. For example, virtually all of the studies cited in this section are concerned about delineating and describing the nature and quality of specific linkages, the positive and negative effects of linkage relationships on the participating organizations as well as on the larger societal and cultural system, and the influence of the interorganizational environment. Other themes include formal and informal interorganizational relationships largely deriving from Selznick (1948) and patterns of linkages within large scale technical contexts (see Reams 1986, Geisler 1986, Maugh 1985, Shrum et al. 1985, Shrum 1984 and 1982, Zinder and Win 1983, and Sayles and Chandler 1971).

Contextual aspects of interorganizational linkages are receiving increased attention from researchers and practitioners. This is not surprising given the fact that resources and other elements coordinated through interor-ganizational relationships are context-specific. Thus, interest appears to be shifting away from universalist

approaches to defining and categorizing organizational linkages toward examining their individual manifestations within particular contexts.

One area currently receiving special attention is the domain of advanced technology development. This is because crafting of complex systems of organizational linkages across the public, private, and academic sectors is the primary strategy by which technology development is encouraged. This trend appears to be intensifying and is likely to continue as a strategy well into the next decade.

Perhaps the most insightful scholarly examinations of this phenomenon are those of Wesley Shrum (1982, 1984, and 1985). As noted earlier, Shrum has advanced the concept of 'technical system' to define the domains in which specific technologies are being developed in the U.S. Technical systems are defined as:

> state-administered networks of actors oriented toward solution of related sets of technological problems. They are 'goal-oriented' or 'controlled' systems in which an interdependency of functions is critical to the success of the system. Innovation, the production of new knowledge and technique in the solution of these problems, is the overriding concern in technical systems. (Shrum 1982: 24)

Shrum identifies two types of technical systems: R&D investment and state sociopolitical systems. R&D investment systems are characterized by private sector market forces and industry-based innovation, but government intervenes in cases where the market is defective yet public benefits from

continued research and development appear to be great. The second type of technical system is most often government controlled and is frequently shaped exclusively by the R&D needs of government. Examples of these technical systems include early government weapons acquisition systems (e.g., the Manhattan project) and the Apollo space program.

This distinction corresponds roughly to the popularly used business and technology development concepts of 'technology push' and 'market pull.' Technology push refers to the drive to create new technologies and to propel them into the marketplace. Market pull refers to forces in the marketplace that render the development of particular technologies desirable because of their profit potential. Most business and technology development recognize that market factors are critical to moving technologies off of the drawing board and into use as solutions to larger-scale technical and economic problems or as profitable items in themselves. Thus, Shrum's (1982) R&D investment technical system is characterized by greater market pull due to government involvement in that area, and the state sociopolitical technical system incorporates technology push concepts to a greater extent.

In both types of technical systems, the dominant characteristic is the complexity of formal interorganizational linkages. Additionally, such systems are characterized by occupational pluralism, cognitive complexity, and

sectoral diversity. Occupational pluralism is reflected in the widespread networks of diverse professionals involved in a given technical system. These networks crosscut organizational and sectoral boundaries and form additional linkages among the organizational participants. Cognitive complexity refers to the need to integrate thousands of unique and specialized components, such as for a space station, and the need to integrate multiple disciplines, such as engineering, physics, chemistry, management, finance, policy, and others, in developing solutions to complex problems. Finally, sectoral diversity refers to the presence of organizations from the government, industrial, academic, and federal laboratory sectors and to the complex problems of linking these different types of organizations into a single technical system.

Of the above characteristics, Shrum (1982) asserts that sectoral diversity may present the greatest challenges. That is, organizations which are traditionally part of different sectors have their own types of facilities and support personnel, their own traditional policies toward personnel, and their own preferred types of research and approaches to conducting research. Creating and maintaining the linkages among such diverse organizations poses problems which are not yet well understood. According to Shrum,

> [k]nowledge of intersectoral linkages remains meager. At a national level this consists of statistics on intersectoral transfers of funds. . . . Others have

> looked at intersectoral mobility at the individual level. Only one study attempted to show the extent of intersectoral communication relationships at a national level, though the indicators were not specific to technological problems. (1982: 23-24)

Shrum (1982) examines the workings of two technical systems, solar photovoltaics and nuclear waste management. He concludes that organizational context is more important than social network factors in determining scientific performance. By organizational context, he means the coordination of interorganizational linkage activities, the policy environment, the marketplace, and cognitive complexity of the task. It is these, he contends, that make or break the eventual realization of technology development objectives, rather than the individual research excellence of the network of technical professionals.

To date, Shrum's work virtually stands alone in its focus on interorganizational linkages across sectors. One other early work examines interorganizational linkage creation and maintenance across sectors by focusing on NASA during the Apollo program (Sayles and Chandler 1971). Sayles and Chandler (1971) were quite likely the first researchers to address the extraordinary problems of integrating a multitude of diverse organizations to solve complex, unknown technological problems. In their case, the technological field of interest was concerned with putting a man on the moon. Among other things, they chronicle the development of Phased Program Planning (PPP), the management

breakthrough for the coordination of interorganizational linkages that ultimately led to goal achievement and program success.

In speaking about the challenges of managing complex interorganizational linkages, Sayles and Chandler describe the paradox between the trend toward "bigness" and economies of scale and the need for coordinating multiple specialized agencies to accomplish large-scale program goals. They conclude that:

> . . . effectiveness in development programs requires a high order of responsible autonomy and the opportunity to innovate and even to change plans. But large-scale projects with the demanding quality and performance requirements of a space program also require unbelievably precise integration and coordination among the parts. While these 'parts' . . . are designed and fabricated in a number of separately organized and directed institutions, with perhaps incompatible objectives, they must intermesh perfectly. (1971: 6)

This leads to two primary questions for theoretical and practical investigation according to Sayles and Chandler (1971). First, large programs are generally mission- or problem-oriented. They require the vigor of cross-disciplinary contributions and collaboration. The problem arises from the fact that professionals within the program are socialized into particular disciplinary contexts, so that their approaches, expectations, and other behavior reflect socialization into particular perspectives. How is the necessary diversity integrated into a larger system?

A second question relates to the temporal quality of social formations present in large technical systems. That is, do the temporary and flexible organizational formats necessary for accomplishing the broad mission become permanent structural entities beyond the range of the technological project? This question enables examination of organizational change through time via technical systems or other large-scale interorganizational linkage settings.

Neither of these questions has been answered sufficiently to provide adequate insight into the structure of large technical systems and the dynamics of the interorganizational linkages which comprise them. Implicit in both of these questions is a concept of organizational culture and its effects on interorganizational linkages. The first question refers to socialization processes while the second question reflects concerns about creation, adaptation and evolution of social formations within cultural systems.

To summarize, the literature on interorganizational linkages is fragmented and diverse. The majority of writings equate resource exchange with interorganizational linkages, either as means or ends. Other writers prefer to examine interorganizational linkages from the standpoint of decision making, contextual effects, and the effects of linkages on intraorganizational operations as well as on the community.

To date, only Shrum (1982) and Sayles and Chandler (1971) have examined interorganizational linkages associated with large-scale technological projects. Both works are concerned with the contextual aspects of interorganizational linkages and both embody emergent concepts of organizational culture as an independent variable affecting linkage creation and maintenance. Shrum (1982) introduces two types of technical systems, R&D investment and state sociopolitical systems. These two types of systems are relevant to the present research project, as are the emergent elements of organizational culture.

This research, then, focuses on interorganizational linkages from the standpoint of both the organizational participants and the context in which linkages are forged rather than from the standpoint of a single linkage characteristic, such as resource exchange or decision making. It is assumed that interorganizational linkages can best be understood with regard to the cultural environment in which they occur. Cultural environment refers to the policy, legal, economic, sociopolitical, and values systems of the larger society that affect interorganizational creation and maintenance.

Contextual influence is particularly important for the present research because the interorganizational linkages examined are fundamental to implementing a federal policy. As Pressman and Wildavsky (1979) note, implementation of any

policy is "a process of interaction between the setting of goals and the actions geared to achieving them" (1979: xxi). Actions for achieving linkage goals do not occur in a vacuum. Since interorganizational linkages are fundamental to implementation of NASA's Commercial Use of Space policy, and, by extension, many similar large-scale technology and economic development policies, they must be examined in the context of the larger cultural environment.

Chapter Three expands on the relationship between organizational culture and interorganizational linkages and presents a formulation of a preliminary framework of analysis. This framework is built around the concepts of congruence, complementarity, and conflict as they relate to organizational forms, operations, and goals in the context of formalized interorganizational relationships.

CHAPTER THREE

RESEARCH DESIGN

Introduction

As stated in Chapter One, the central problems to be investigated in this research are 1) the nature and extent of influence of organizational culture on interorganizational linkages and 2) the effects of linkage creation and maintenance on the implementation of technology and economic development programs. The setting for the research project is the Commercial Use of Space (CUS) Program of the National Aeronautics and Space Administration (NASA). This chapter presents the overall research design, including data collection strategies and the analytical framework. Preliminary findings are also summarized as they relate to the hypotheses formulated for data collection, assembly, and analysis.

Design of the Research Project

The research was developed from three propositions. These propositions reflect assumptions about organizations and interorganizational relationships as follows:

I. Organizations are unique, goal-directed, stable social formations that can be modeled after cultural systems having an operating economy, power hierarchies, social and communication networks, and value systems.

II. Interorganizational relationships, or linkages, are established for purposes of strengthening the stability of each organizational participant by providing for resource acquisition, efficient operations, and/or market stability and for implementing large scale policies and programs.

III. The corporate, or organizational culture of an organization plays a significant role in the creation and maintenance of linkages with other organizations, regardless of the purpose for which the linkage is formed.

These propositions provide the foundation on which the research project was organized. Proposition I presents the concept that organizations can be characterized as cultural systems. Thus, the differences between one organization and another derive from an entire constellation of attitudes, symbols, internal social formations, power relationships, and economies which are analogous to cultural systems in the broader human perspective. This research, however, is not

organized around the task of explicitly characterizing a given organization's culture. Rather, we assume that organizations have cultures and seek to establish the effects of similarities and differences between and among the cultures of organizations involved in a linkage relationship.

Perspectives on organizational culture derive from perspectives on culture in general. Thus it is impossible to explore organizational culture without reference to the major schools of thought present in theories about culture. Primary streams of thought, as noted in Chapter Two, are examined in this research: culture as revealed by symbolic representation and culture as revealed by observable behavior. Both perspectives are crosscut by the use of culture as both dependent and independent variable. Hypotheses presented in the following section illustrate these varying conceptualizations about culture in general and organizational culture in particular.

Proposition II asserts that interorganizational linkages are desirable interactive states for organizations. Research has shown that linkage relationships, whether informal or formal, enable individual organizations to stabilize acquisition of necessary resources for operations, achieve desirable levels of activity, and maintain viability in unstable environmental settings. As we have seen in Chapter Two, even competing organizations may enter into

strategic interorganizational linkages to ensure stability within particular settings. Thus, it follows that the creation and maintenance of linkage relationships are of fundamental importance for the long-term survival and adaptability of organizations as social formations within the larger human cultural environment.

Further, interorganizational linkages are a traditional and necessary means to implement policy on national, regional, and local levels. Through formalized linkage relationships, organizations combine resources, personnel, expertise, and other elements to carry out program directives and achieve overall program and policy goals. Interorganizational linkages are, thus, a critical component of large-scale program delivery strategies, and their formation and stability over time may determine program outcomes and policy success.

Finally, Proposition III assumes that an organization's culture affects the formation, maintenance, and outcomes of a particular linkage relationship. As we saw in Chapter Two, social scientists have generally examined interorganizational relationships in terms of their functions as resource exchange mechanisms or in the light of contextual characteristics. Linkage outcomes have often been examined by way of evaluation research efforts to determine whether or not programmatic goals were achieved. Resource allocation and reciprocity are frequently cited determinants of

linkage outcomes, however, other elements are also recognized as equally important determinants. Power hierarchies, decision-making, social and professional networks, work group organization, the regulatory environment, and other elements have generally been examined separately, but together they comprise an emergent concept of organizational culture and form the basis for operationalizing the concept. This research assumes, then, that the more general concept of organizational culture can be operationalized to provide a fuller and richer understanding of the dynamics of interorganizational linkages.

Proposition III provides the basis for explorations into how organizational culture affects linkage relationships. Thus, organizational culture is treated as an independent variable. Further, this proposition generates a framework for analyzing linkage outcomes. This framework is comprised of three "states": congruence, complementarity, and conflict. Each state encompasses a limited range of factors that can be used to compare similarities and differences between organizational cultures in linkage situations and to predict linkage outcomes.

Congruence refers to situations wherein the organizations involved in linkage negotiations or linkage maintenance exhibit strong similarities in organizational culture. Specifically, similarities in organizational

goals, decision-making processes, organization of work groups, operating systems, and resource tracking and allocation procedures should lead to predictions about linkage outcomes. Theoretically, congruence means that the linked organizations do not have to alter any cultural elements to operate within linkage contexts. Additionally, congruence implies that the participating organizations share similar noncompetitive goals and that the achievement of the linkage goal(s) is of benefit to congruent linkage participants.

Complementarities between two organizations exist when there are differences in organizational culture, but the differences do not interfere with linkage activities or goal achievement for each organization. Neither organization must alter its primary formal arrangements to participate in linkage relationships or to achieve desired ends. Complementarity may even enhance goal achievement for each participating organizaton if achievement of one linkage participant's goals enhances the achievement of different goals for the other linkage partners.

Conflict states exist when one of two situations is present. First, conflict occurs when significant differences in organizational culture prohibit the achievement of the participants' goals in a linkage relationship. This situation may exist when organizations enter into linkage relationships with little or no knowledge

about each other, such as may occur in implementation of new programs. Here, conflicts can be resolved through adaptation of one or several organizational cultural elements so that tasks essential for achieving linkage goals can be carried out successfully.

Second, conflict may exist when achievement of one partner's goals precludes achievement of the other linkage participants' goals. For example, the goal of a federal government agency may be to make critical knowledge and technology generally available to industry for commercialization. An interested business organization may wish to link with the agency to develop the technology on an exclusive basis for its own competitive advantage in the industry. If an exclusive arrangement is negotiated, the agency may be unable to fulfill its wider technology transfer goals. If an exclusive arrangement is not available, business organizations are likely to refuse linkage opportunities with the agency since individually, they can derive no competitive advantage from the arrangement. Thus, achievement of government public service goals may preclude achievement of industrial profitability goals, or vice versa. Resolution of goal conflicts may be the most difficult of tasks for successful linkage relationships.

Together these three propositions generate the following hypotheses for testing in the research project:

A. The members of an organization are more likely to create a linkage relationship with another organization when they have some familiarity with the organizational culture of the potential linkage partner. Conversely, they are less likely to pursue linkage creation when they are unfamiliar with the organizational culture of the potential linkage partner or if they perceive significant differences in organizational culture.

B. The creation and maintenance of organizational linkages are more dependent upon compatible operations and outputs than on organization size, employee mix, or resource exchange criteria.

C. The members of an organization are more likely to pursue linkage relationships with other organizations when potential beneficial outcomes are clearly understood.

D. Organizations are more likely to pursue linkage relationships, if linkages are a significant element of past experiences and traditions.

E. The members of an organization are more likely to pursue linkage relationships with another organization if previous linkage relationships with that organization have produced positive outcomes.

F. The members of an organization are more likely to pursue linkage relationships that are similar in structure and function to previous linkage relationships than relationships which are dissimilar in structure and function.

G. The amount of time devoted to linkage maintenance activities by program managers will vary inversely with their degree of knowledge about the culture of the "other" organization.

H. Maintaining a linkage relationship depends more on the adaptability of each organization to the culture of the other than on the terms of an original formal contract. Conversely, failure to maintain a linkage arrangement between two organizations will result as often from failure to adapt to cultural incompatibilities as from other factors.

The overall research strategy utilized in this project centers around ascertaining the effects of organizational culture on linkage creation and on linkage maintenance.

Hypotheses A, C, D, E, and F relate specifically to linkage creation, while hypotheses G and H are concerned primarily with linkage maintenance. Hypothesis B relates to both linkage creation and maintenance. All of the hypotheses are relatively simple and straightforward since their primary purpose is to act as a set of heuristic guides for the research.

Hypothesis A examines two independent, but related aspects of organizational linkage creation. First, the degree of understanding about the culture of a different organization is hypothesized to be a significant factor in linkage creation. Thus, if the members of one organization believe that they understand the culture of another organization, in terms of operations, structure, decision-making, resources, and goals, then the decision to develop formalized relationships with that organization will be made on the basis of that understanding. It should be noted that the accuracy of the understanding is theorized to be not as important as whether or not individuals believe they understand the culture of another organization.

Second, linkage development is hypothesized to be determined to a greater extent by perceptions of similarities or differences between organizational cultures on the part of organizational members. Thus, the degree of understanding which organizational members believe they have about the culture of another organization should lead to

assessments of how similar or different the two organizations are. In other words, if the organizations are perceived to be congruent or complementary, then linkages are more likely to be pursued. If, on the other hand, the organizations are perceived to be different, or conflicting, then linkages are less likely to be pursued.

Hypotheses B, C, D, and E explore the effects of specific organizational cultural factors on linkage creation. These hypotheses are related in that they provide a vehicle to explore the effects of functional versus structural compatibilities between organizations, perceived benefits of linkage relationships, and the influence of past traditions with regard to linkage relationships with different organizations and with the same organization. Hypothesis B focuses on the relative importance of congruence or complementarity between different elements of organizational culture, while Hypothesis C examines whether or not a priori assumptions about outcomes positively or negatively influence linkage creation. Hypotheses B and C are related in that perceived congruence or complementarity in organizational culture and linkage goals are theorized to determine whether or not linkages are or should be pursued.

A simple way to determine whether linkages with NASA are associated with perceptions about the congruence, complementarity, or conflict between organizationsl cultures is to compare NASA-linked companies with unlinked companies

on several operational variables, including company size, company type, employee mix, and available resources. Additionally, predictions about linkage creation can be examined by comparing general degrees of congruence, complementarity, or conflict between organizational operations. Adjustments to normal operating processes made by a company in order to link or to maintain a linkage with NASA can also be compared to gain an understanding of the extent of organizational adaptation required and actually made.

Changes in operations and/or other organizational processes made in the linkage context should reflect attempts to reduce conflict and augment congruence or complementarities between the company and NASA. Such adjustments, or changes, result in organizational change and adaptation that would not have been necessary, perhaps, had no linkage occurred. Such change and adaptation will, in turn, illuminate the areas where congruence or complementarity must be achieved in order to link. Thus, if NASA linkages cannot be predicted from perceived congruence or complentarity in areas such as company type, size (measured by number of employees), extent of resource base, and types of employees, then it is possible that congruence or complementarity in other variables, such as operations and processes are better predictors. If congruence and complementarity between internal formations and/or

operations are better predictors of linkages, then it should be possible to theorize about the relationship between linkages and organizational change and adaptation.

Furthermore, these hypotheses allow us to examine the validity of assumptions held by many program managers within NASA and other organizations involved with CUS activities. These assumptions center primarily around the idea that one set of organizational culture variables, such as company size, amount of available investment capital, and a strong R&D emphasis, are more forceful determinants of CUS linkage creation.

Hypotheses D, E, and F are all concerned with the existence of patterns of organizational cultural congruence or complementarity and the effects of such pre-existing patterns on linkage creation. Hypothesis D simply asks whether or not a history of interorganizational relationships is a good predictor of future linkage creation, while Hypothesis E focuses on the effects of previous linkage relationships between the same organizations. Together, Hypotheses D and E test the assumptions that successful past linkage experiences, in general and in particular, will predispose an organization to pursue additional linkage relationships and that the existence of past linkages indicates the presence of cultural congruence or complementarity between previously linked organizations.

Again, these hypotheses also provide a means to test additional assumptions that are widespread within the commercialization of space arena. In this case, the assumptions are reflected in patterns of linkage behavior, as linkages have generally been pursued with large aerospace corporations which have a long linkage tradition with NASA. Whether or not this pattern reflects the power of tradition within organizational cultural systems or the power of existing congruent and complementary cultures of large corporations and government, or some other influence can be examined through these hypotheses.

Hypothesis F follows from Hypotheses D and E, but focuses on the power of previously established patterns of interorganizational linkages on the types of subsequent linkages. Hypothesis F asks whether or not organizations that have benefitted from previous organizational linkages of a given type will establish linkage relationships which are significantly different from previously successful types. It is reasonable to expect that once a pattern of successful linkage relationships of a given type has been established, it will be extremely difficult to devise new types of linkage relationships which may require adaptations of a particular organization's cultural system.

Hypotheses D, E, and F allow us to examine the relationships between established linkage patterns between organizations, such as NASA and its traditional array of

aerospace contractors, willingness to seek new types of linkages, such as those mandated in commercial space programmatic activities. With its relatively strong and dominant tradition of nonegalitarian contractor-type linkages, questions arise as to whether or not NASA and private sector organizations can or are willing to adapt their organizational cultures to create more egalitarian linkages in the context of CUS.

The remaining hypotheses, G and H, are devoted to questions about linkage maintainence. These hypotheses examine the effects of organizational culture on maintaining linkages. They are logical extensions of the hypotheses about linkage creation in that they are designed to explore whether or not comgruence, complementarity, or conflict are important factors in linkage maintenance as well as in linkage creation. Congruent, complementary, or conflicting organizational cultures are hypothesized to influence linkage maintenance activities to a greater extent than other factors, such as specific formal contractual or other legally binding agreements. Whether or not formal contracts require organizational adaptation can also be examined.

Together these eight hypotheses were designed to guide the overall research into relative influence of organizational culture on interorganizational linkages. They were also designed to test not only general propositions about the nature of organizations as important social formations

in human cultural systems, but also to test assumptions about organizational linkages and specific linkage creation strategies within a particular federal program, that is, the Commercial Use of Space Program. The following section describes the methodology employed in the study to test the eight hypotheses discussed above.

Data Collection

Data collection was carried out over a two and one-half year period beginning in 1986. During this time data were collected and assembled through a variety of methods, including participant-observation at conferences, seminars, and other NASA-CUS outreach events, indepth interviews with both NASA and industry personnel, and a national survey of executives of small and medium-sized high technology nonaerospace companies. Participant-observation yielded information and insight into NASA-business interactive processes and distinctive frames of reference revealed by the interactions. Interviews provided opportunities to explore in more detail these alternative, and sometimes competing, frames of reference and the interorganizational conflicts they generate in linkage contexts. The national survey was designed to ascertain whether or not the findings from the qualitative data collection techniques were generalizable to the universe of small to medium-sized high technology companies.

Using the information yielded by qualitative techniques, the first task for the survey portion of the research was to identify the most appropriate sample for data collection. First, since the CUS program is oriented toward nonaerospace companies, those companies appeared to be more appropriate for the focus of the research project than NASA, itself. Not only were there continued difficulties in accessing the appropriate NASA personnel, but preliminary research and participant observation of NASA-industry commercial space seminars and conferences indicated that most of the CUS implementation strategies were based on erroneous assumptions on the part of NASA program managers and their corporate contractors about the nature of nonaerospace companies, particularly small and medium-sized high technology companies.

CUS program managers assumed that 1) the most effective means for encouraging nonaerospace companies to link with NASA was via scientific presentations to the corporate R&D staff about the physical attributes of the space environment and the array of facilities and resources available through NASA, and 2) only large companies could or would be interested in forming linkages for commercial space activities.Consequently, it was felt that the accuracy of these assumptions could best be examined by focusing the survey on the private sector, rather than on NASA.

As discussed in Chapter One, large corporations were the focus of most initial CUS program activity because it was assumed by NASA and by the Boeing/Peat Marwick team that only large companies would have the financial and professional resources necessary to undertake R&D projects in the program. This assumption reflects the pattern of traditional linkage arrangements between NASA and private industry. Further, the Boeing/Peat Marwick team, as well as the previous Booz Allen and Coopers Lybrand teams, had made extensive contacts with large corporations, including many with long histories of NASA relationships. However, the more egalitarian nature of the CUS linkage formats appeared to open the door for smaller companies to become involved with NASA. Thus, small and medium-sized companies represented a virtually untouched population of companies for more systematic testing of the variables emerging from participant-observation and interviews.

The pilot studies

In order to clarify the variables and their operationalization and to develop the most effective data collection instrument, two pilot studies were carried out. Both of these pilot studies involved companies with current NASA linkages. These companies were identified and verified from literature and other materials compiled by NASA and the Boeing/Peat Marwick Commercial Space Group. Since they were

already involved with NASA as part of the CUS program, it was felt that they would provide insight into the nature of CUS linkage creation and improve subsequent full-scale data collection strategies.

The first pilot study consisted of open-ended telephone interviews with the presidents and/or vice-presidents of five companies linked with NASA in the CUS program. These companies represented the technology areas of biotechnology, energy, advanced materials (ceramics), and automation. The interviews centered around the company's involvement in the CUS program, whether or not the company had prior involvement with NASA, and the quality of the company experiences with the current and/or past linkages with NASA. It is interesting to note, that while these companies were listed as having present involvement with NASA as part of the CUS program, only two of the respondents could actually verify such involvement.

In related matters, however, the executives' responses reflected a range of attitudes and opinions about government red tape, complex, confusing, and everchanging technical specifications, the impossibility of meeting all NASA documentation and quality control requirements, and the benefits of past NASA relationships. The responses ranged from strongly negative to mildly positive, but the overall impression was that while industry-NASA linkages could be extremely beneficial, they generally were difficult to

maintain and yielded somewhat disappointing results. A copy of the interview schedule for the telephone interviews appears in Appendix B.

The outcomes of the telephone interviews were incorporated into a pilot survey questionnaire which was mailed to thirty of the high technology companies previously identified. The pilot survey instrument was open-ended in order to obtain additional detailed information on the individual experiences of the responding companies with respect to NASA involvement or lack of NASA involvement. Of the thirty companies surveyed in this pilot, eight (27%) returned completed questionnaires.

Results of the pilot questionnaire indicated first that the open-ended nature of the instrument was not effective in eliciting meaningful responses. Respondents either stated plainly that they were too busy to fill out all of the required discussion areas or simply ignored them in favor of the closed questions on the form. Second, responses tended to confirm the overall impressions gained from the telephone interviews with regard to impressions about NASA, experiences with NASA linkages, and other government agency relationships. Finally, the response rate was assumed to represent the probable response rate for the primary survey instrument. From these experiences, a survey instrument with both closed and open questions was determined to be the

best means for eliciting maximum information from high technology company executives.

Selecting the sample

Large scale sampling of high technology companies followed the two pilot study projects. This phase of the research required a comprehensive listing of small and medium-sized high technology companies throughout the U.S. in order to determine appropriate sample size and technology area representation.

Unfortunately, identification of the population of small and medium-sized high technology companies in the U.S. is a difficult task, since few comprehensive directories are available. Of those that are available, many list only companies which are publicly held or which are very large, such as directories published by Dun and Bradstreet, Standard and Poor's, and Moody's. Other directories, primarily assembled by professional technical societies, are industry-specific. The problem was to acquire a directory of privately and publicly held companies spanning a broad range of industries.

The directory selected was the 1988 edition of the Corporate Technology Directory, published by Corporate Technology Information Services, Inc. The "CorpTech" Directory contains records for over 25,000 U.S. entities that "manufacture or develop high technology products"

(CorpTech 1988: vi). This total includes over 7,000 operating units of larger corporations, over 14,000 private firms, and over 2,000 public companies. Consequently, the CorpTech Directory provides access to a wide range of public and, more significantly, private high technology companies in an array of technology areas.

The major disadvantage of the CorpTech Directory is that it does not include every company in the U.S. Despite its reputation as the most comprehensive directory of business and industrial organizations available, the Directory itself relies on survey responses for its company listings and data. Thus, it contains a self-selected sample of companies. The only directories which contain the entire population of companies, however, are usually those which rely on such government documents as the Form 10-K, filed annually by publicly held business entities. For sampling purposes, this has the disadvantage of eliminating all of the privately-held companies in the U.S. Consequently, despite its shortcomings, the CorpTech Directory appeared to offer the most comprehensive listing of both public and private companies across the widest variety of high technology domains.

Technology areas included in the CorpTech Directory include automation, biotechnology, chemicals, computers, defense, energy, manufacturing, advanced materials, medical, pharmaceuticals, photonic and optics, services, software,

subassemblies and components, test and measurement, telecommunications, and transportation. These technologies are the best worldwide representation of high technology available at the present time. They also represent a more complete categorization than is available elsewhere, such as the Standard Industrial Classification (SIC) codes developed by the U.S. Office of Management and Budget.

For research purposes, the sample of high technology companies was selected using both technology area and size of company, the latter being a strong determinant of differences among companies. The Directory lists company size on two variables: number of employees and annual sales revenues. Annual sales revenues was used as the selection variable because it was precoded in the indices and is directly correlated with number of employees. For example, a company with over $500 million in annual sales is almost certain to employ over 500 employees. Number of employees could have been utilized for the same reasons, however that measure was not precoded into the indices; it appeared only in the individual company descriptions.

Technology areas were selected on the basis of their probable relevance to NASA's space-based and space-related advanced technology areas within the CUS program. Space commercialization emphases include materials processing in microgravity, earth and ocean observation (remote sensing), communications, and industrial services. Consequently, the

technology areas selected for sampling were chosen for their relevance to CUS industry development thrusts. That is, each technology or product logically might benefit from R&D activities carried out in the space environment (aboard the space shuttle, space station, or on the Industrial Space Facility) or carried out using laboratories, equipment, and other resources at NASA Field Centers and/or federal laboratories around the U.S. These areas, as utilized by the CorpTech Directory, are: automation, biotechnology, chemicals, computers, energy, manufacturing, advanced materials, medical, pharmaceuticals, photonics and optics, services, software, and test and measurement.

Thus, biotechnology, chemicals, energy, manufacturing, advanced materials, pharmaceuticals, and artificial intelligence hardware and software are relevant to the CUS area of materials processing in space (MPS). Photonics and optics can be logically related to both the satellite communications and remote sensing components of the CUS program, while services, testing and measurement, automation, and medical can be associated with the Industrial Services component of the CUS program.

Each of these technology areas is further subdivided by the CorpTech Directory into more specific technologies. Thus, automation is subdivided into the areas of assembly and manufacturing systems, manufacturing controls, flexible manufacturing systems, materials handling and shipping

equipment, manufacturing measuring equipment, machine tools, presses and other equipment, machine vision systems, robots and robotic equipment, and test equipment. These subcategories are refined even further, such as in the case of machine vision systems where subtopics include components, vision identification systems, light-based machine vision systems, laser-based machine vision systems, part sorting systems, etc.

In an effort to streamline sample selection activities and to collect meaningful data, certain technology areas and sub-categories were omitted from the sample pool. One of these was defense. Defense industries were omitted as a sampling category because of the classified nature of much of the work, and becasue this category includes most, if not all of the large aerospace companies that already have long histories of interaction with NASA. Since the project was designed to examine small and medium-sized high technology companies rather than large aerospace corporations, defense-related companies were not included in the sampling categories.

The subassemblies and components category also was not selected for sampling because of the indirect nature of the products for the CUS program. It appeared that most of the companies listed in this technology area are those which produce such things as valves, motors and motor parts, power converters, bearings, circuit boards, etc. These companies

were thought to be involved with NASA in subcontractor roles to prime contractors as suppliers of required parts and components. This category may be examined in subsequent studies, if it appears that such companies are relevant for space-based or space-related R&D projects fundamental to the CUS program.

Transportation also was not selected for this research because it does not appear that the companies are directly relevant to commercial space activities. For those corporations that are listed in this technology area, again, most are defense and aerospace-related.

Telecommunications was not selected for this research project because of its overwhelming emphasis on television and radio broadcasting, movies, telephones, and so forth. Again, companies within this technology area may be sampled at a later time during subsequent studies if it becomes apparent that these areas are relevant to commercial space policies and programs.

Finally, certain subcategories within technology areas were omitted from the sampling categories, because they were clearly irrelevant to activities associated with the CUS program. For example, only one subcategory within computers was selected for sampling, "Artificial Intelligence Hardware." Other subcategories were not selected for sampling because they contain listings of companies already listed under other technology areas, such as subassemblies

and components, and because they appeared to be largely irrelevant to space-based R&D within CUS program activity areas. The same held true for the technology area of "Software," in that the only sub-category selected was "Artificial Intelligence Software." In other technology areas, subcategories were eliminated according to their lack of relevance to the space program in general and to CUS program objectives in particular.

To summarize, technology areas selected for sampling were chosen based on their apparent relevance to possible R&D activity areas within the CUS program. This is not to say, however, that the categories selected had to show clear relevance to space-based and/or space-related R&D. In fact, many of the categories selected are likely to be only marginally relevant to CUS program activities. Rather, categories were omitted because they have no apparent relevance at present or are comprised of large aerospace and defense-related corporations with largely inaccessible classified R&D activities. Similar research efforts may be designed for these categories at a future time.

After selection of the technology areas and categories for sampling, the Technology Area Index of the CorpTech Directory was used for selection of the companies. Companies themselves were chosen on the basis of size, as measured by annual sales revenues, on the basis of whether they were U.S. or foreign owned entities, and on the basis

of whether they were for-profit or non-profit organizations. As a general rule, companies were selected only if they were for profit, U.S. owned entities, and if their annual sales revenues did not exceed $100 million.

The figure of $100 million was chosen despite the fact that standard federal government measures of "small business" generally use the figures of $500 million and/or 500 or fewer employees (see, for example, the numerous publications of the U.S. Small Business Administration). It was felt that in reality, $100 million was a more realistic upper boundary for the category of "small and medium-sized" business. Business organizations which exceed $100 million in annual sales revenues are more likely to have accounting systems, management teams, and other elements in place with which to interact more effectively with government agencies in contract-type relationships. Within the CorpTech Directory they also comprised a large number of aerospace and defense-related industry organizations.

Further, it was expressed during interviews with various company executives, both as part of the pilot studies and in addition to them, that $100 million functions as a significant milestone in company growth. After reaching and exceeding that figure, companies are frequently the subjects of increased federal investigatory activity with respect to affirmative action and other regulatory systems. According to several industry informants, many

company executives deliberately spin off separate and independent companies with ties to a parent, or "holding," company as a way to avert what they feel is unnecessary, time consuming effort to demonstrate compliance with numerous federal regulations. Whether or not this practice successfully avoids such regulation and whether or not it results in abuses of labor, affirmative action, accounting, and other federally-monitored public interest programs is unknown and is a provocative area for future research.

Despite setting an upper boundary of $100 million, however, the sample did incorporate many companies which exceeded this limit. This was due to the nature of listings of companies within the CorpTech Directory itself. Many companies are listed as independent entities with their own sets of executive officers and their own income levels when in fact, they are entities of larger corporate units. Thus, some very large corporations were present in the sample since several of their independent operating divisions were selected.

Each of the companies that corresponded to the criteria of for-profit, U.S. owned, and $100 million or less in annual sales revenues that was also listed within the chosen technology areas in the Technology Index was consecutively numbered. The result was a total of approximately 9,958 companies available for sampling. A random number list was

then generated by computer, and companies were selected by proceding through the random number list.

One significant problem emerged, however, in that most companies were listed in more than one technology area, category, and subcategory. Thus, the numbering system included duplications of companies. The problem was solved during actual selection of each company, by using the technology coding system that is part of every company's profile to identify all other listings of that company in the Technology Index. The other listings were then eliminated from further selection by random number. Thus, if a number resulted in the selection of XYZ Advanced Materials Company, all other places where XYZ Advanced Materials Company was listed were identified and the assigned numbers crossed out. If one of those numbers then appeared later in the random number list, it was immediately known that XYZ was already part of the sample and that it should not be utilized again.

Survey questionnaire

The survey questionnaire incorporated responses to the pilot interviews and questionnaire. Responses were translated into data collection variables in both "agree/disagree" and Likert scale formats. Although most questions utilized a closed format in keeping with responses on the pilot studies, provisions for additional comments and

written explanations of variable selection (or nonselection) were made. Thus, there were several opportunities for qualitative responses. The questionnaire was ultimately professionally typeset, printed on yellow paper, and collated into a booklet. A copy appears in Appendix B, although it is presented in a format other than that actually disseminated to comply with University of Florida dissertation requirements.

The questionnaire was organized into four parts. Part One solicited general information about the respondent's company, including the founding date, number of employees, annual sales revenues, the number of scientists and engineers on staff, percent of income derived from government contract work, general industry characteristics, and most important R&D goals and activities. All respondents were requested to complete Part One.

Data from this portion of the survey instrument were used to elicit several organizational culture elements for profiling and comparison of companies. For example, information about company size, revenues, R&D goals, and other government linkage experience could be compared with NASA linkages to determine whether or not linkage experience is generally associated with particular characteristics.

Part Two was also completed by all respondents. Questions in this section revealed respondents' self-reported knowledge about various aspects of the space

environment, NASA linkage formats, CUS program areas and industries, NASA resources and facilities for R&D, and general "outreach" or marketing mechanisms. These questions tested major assumptions on the part of CUS program managers about the level of knowledge and awareness "out there" among private sector companies. They also permitted comparisons of levels of self-reported knowledge with technology areas, types of companies, and NASA linkage experience. Information resulting from these questions was used to determine the similarities and differences of the frames of reference on the part of executives of small and medium-sized high technology companies, NASA, and related CUS program personnel. Differing frames of reference indicate different organizational culture perspectives which can play important roles in linkage contexts.

Part Three of the survey was designed for only those respondents with previous or current linkage experience with NASA. Questions were oriented toward the type of linkage arrangement, linkage creation processes, organizational and linkage goals, linkage outcomes, and comparisons with other industry-government linkage experiences. Respondents were also asked to describe any significant constraints to their NASA linkage activities and outcomes, such as whether internal organizational adjustments were required for their companies to maintain the NASA relationship. This

information provided insight into the effects of linkage traditions on subsequent linkage development.

Part Four addressed those companies with no previous NASA linkages. Respondents were polled about their reasons for not considering and/or not pursuing such relationships, their awareness of NASA linkages among competitors, and their experiences with other types of NASA relationshps, such as Small Business Innovation Research (SBIR) grants. Questions also were asked about any other company-NASA interactions. Of particular interest was information which could be used to compare perceptions about linking with NASA among these companies and between these companies and those with previous or ongoing NASA linkages. Significant differences in attitudes toward NASA on the part of companies with and without NASA linkage relationships should lead to insights about why companies do or do not seek linkage relationships. Similarities in attitudes will lead to new questions about the driving forces for linkage creation.

The questionnaire was mailed to the sample of 1200 small and medium-sized high technology companies, along with a cover letter signed by the Director of the Southern Technology Applications Center and a postage-paid return envelope. After the deadline specified in the initial mailing, approximately 275 responses were received. A second mailing of the questionnaire with a "reminder" cover

letter was mailed to the remainder of the sample. This produced a somewhat lower response, as expected. However, the two mailings resulted in approximately 425 responses, of which a total of 403 (an overall response rate of 32%) were usable for data analysis.[1]

A number of recipients of the survey telephoned to ask for more information about the survey and the research goals. In every instance the requested information was provided, and the respondent was engaged in further conversation about his/her company and the existence of past or current linkages with NASA. These impromptu interview sessions generated additional qualitative and anecdotal information for the study.

In addition to these numerous "impromptu interviews," ten respondents were contacted by the researcher to solicit clarification and additional information. These individuals were those whose completed survey questionnaires contained a large quantity of volunteered comments which were especially provocative. No interview schedule was utilized for these interviews because each interview was focused on particular comments of an individual respondent. The goal of both

[1] Subsequent to this phase of the research I was made aware of the existence of techniques such as those presented in Dillman (1978) to increase response rates. While the 32% response rate is sufficient for the majority of analytical strategies utilized in this research, a high rate is always more powerful. Had I known of such techniques prior to this project they would have been incorporated as appropriate.

types of interviews was to clarify and verify information already assembled from the survey responses.

To summarize, the research strategy was built around three propositions related to organizational culture and its influences on interorganizational linkages. A multi-method data collection strategy was utilized, including participant-observation of numerous industry-NASA conferences, seminars, and workshops, interviews with NASA program personnel and company executives, thorough review of all CUS program related literature, and a national survey of executives of small and medium-sized high technology business organizations. Chapter Four presents data revealed by the qualitative techniques and provides the ethnographic context in which the subsequent qualitative and quantitative analyses were carried out. Chapter Five discusses the results of survey data analysis augmented by additional qualitatively generated information. Chapter Six summarizes the most significant findings and their implications in relation to the propositions and hypotheses guiding the research.

CHAPTER FOUR

ORGANIZATIONAL LINKAGES IN THE SPACE PROGRAM

Introduction

This chapter presents background and contextual information derived from indepth interviews, participant-observation of numerous NASA-industry workshops and NASA training sessions for CUS participants and extensive reviews of CUS program literature. The chapter discusses the history and emergence of the Commercial Use of Space (CUS) Program, traditional linkages and interdependencies between NASA and the aerospace industry and the new linkage formats associated with the CUS program in an ethnographic context. The chapter concludes with a discussion of the major problems posed by the implementation of nontraditional linkage formats within traditional industry-NASA relationships as revealed by the qualitative phase of the research.

Traditional Organizational Linkages In the Space Program

Industry-government interorganizational linkages have a long history in the U.S. Over time, linkage relationships between government agencies and private sector business and

industrial organizations have become patterned and institutionalized. The principle underlying these traditional interorganizational linkage relationships is that government obtains from the private sector needed goods and services at a competitive market price. The process of soliciting bids, quotations, and proposals from the private sector is now a complex, sophisticated and highly regulated enterprise, and government procurement officers frequently wield great power over organizational processes and interorganizational linkage formation and maintenance.

NASA-industry linkages are part of the enormous linkage formation and maintenance traditions that dominate virtually all government procurement. Business and industrial organizations compete with one another to win contracts and purchase orders in order to "sell" products and services to NASA.[1] As buyer, NASA selects the best products and services for the lowest price to achieve programmatic goals and maintain an acceptable level of accountability to Congress and the public.

As with other government agencies, NASA's traditional linkage arrangements have produced interdependencies between it and a fairly stable constellation of contractor

[1] Throughout this chapter, terms such as "NASA controls," "organizations behave" or "companies expect" are used. While some readers may interpret this usage as unnecessary reification, it is less cumbersome to use corporate persona than to specify continually that it is the individual members of each organization that "control," "behave" and "expect."

organizations. "Interdependency," in this context means organizations in the system require linkages for their survival. In this particular system most of the supplier organizations have come to depend in large part on NASA contracts (or on government contracts in general) to maintain their existence over time. Loss of contracts is a severe threat to an organization's viability, and is one of the harshest penalties for organizational misconduct in contractual situations.

For its part NASA is also highly dependent on the performance of its contractors to provide high quality components for booster engines, scientific satellites, the shuttle, spacesuits, communication, and other elements required for space activities. Substandard performance by a contracting organization wastes taxpayer resources, hinders achievement of NASA goals, damages NASA's reputation as well as its own among Congressional policymakers and the general public, and threatens NASA's future budget allocations. Consequently, the tasks of overseeing contract competition, awards and performance are of vital importance, and elaborate control systems have evolved to maintain NASA's (and other government agencies') power over these interorganizational linkage relationships.

These interdependencies are perpetuated by organizational cultures that reinforce traditional procedures, operations, interorganizational relationships,

and values. Additionally, interdependencies are reinforced by the benefits derived by each of the interdependent organizations over the long term.

Government benefits from this interdependency by obtaining sophisticated services and products at a competitively low price and by controlling the relationship and the quality of the purchased goods and services. Further, government can demand any changes in product quality or other specifications from contractors at any time during the relationship according to the political whims of Congress, budget shortfalls, or other reasons (Sayles and Chandler 1971). Thus, government benefits include control of linkage formation, terms, and maintenance as well as receipt of essential goods and services for continued viability.

Industry benefits from the interdependency through the development of government as a major market for goods and services. As a reliable and long-term purchaser of products and services, government can be a steady source of sales and profits. Further, business organizations benefit from the development of new technologies and products that "spin off" from many contract activities. These spinoffs can either be developed for new consumer products at a later time or can be patented and licensed to another company for further development. In the latter case, fees and royalties paid to the patent holder may constitute a sizeable income source.

Intense competition among industrial organizations to win government contracts produces significant degrees of resource, policy, and market instabilities for organizations dependent on consistent and continuing government purchases of their goods and services. These instabilities must be overcome to maintain organizational viability over the long term. Thus, companies act in various ways to stabilize uncertain elements and ensure long term survival.

For example, in order to stabilize their operations and environment, some companies engage in practices which, if not illegal, are certainly unethical. Recent well publicized cases of fraudulent overcharges to the government for various products may reflect attempts to stabilize profits or resource acquisition. Corporate spying is another side effect of the intense competition for lucrative government contracts, and companies sometimes take elaborate precautions to protect their proposal writing teams by sequestering them in secret locations or by destroying drafts rather than putting them in the wastebasket.

Many companies utilize formal linkages with one another as a strategy for long-term competition. To illustrate, competition for the enormously lucrative second phase work package for NASA's space station led to the situation where some companies not only developed proposals as prime contractors, but also were included as subcontractors in the proposals of other would-be prime contractors. Thus TRW

submitted a proposal for a prime contract estimated to be worth a total of $1 billion for Segment IV. TRW was also a major subcontractor in prime contract proposals submitted by Boeing for the $2.5 billion Segment I, by Rockwell for the $3.7 billion Segment II, and by General Electric for the $750 million Segment III. Similar relationships were developed by McDonnell Douglas and RCA (Gwynne 1987, Aviation Week and Space Technology, December 7, 1987). Thus, if a company did not win a prime contract, it was still in a position to benefit by subcontracting to the winners of the other space station work packages.

Such strategies are not uncommon among business and industrial organizations with strong interdependencies with government. The stakes are high. The intensity of competition and the importance of maintaining an acceptable level of government contract awards are major driving forces for the creation and maintenance of government-industry linkages. They also produce an inherently unstable environment that, in turn, encourages development of a range of adaptations.

One type of organizational adaptation in this context is toward isomorphism (DiMaggio and Powell 1983). That is, organizations modify their decision hierarchies, operating procedures, and other cultural elements to conform more closely with one another or with a dominant powerful core organization such as NASA or other government agency.

Eventually groups of organizations become recognizably distinct from other groups, much as aerospace organizations are recognizably distinct from those in the health care industry. At the very least multiple, complex and ongoing linkages among aerospace organizations and NASA reinforce the collective unity of the aerospace industry and impart a distinctive and isomorphic character to it.

Organizational Culture in the Space Program

Isomorphism in the aerospace industry enables NASA program managers generally to predict company behavior in linkage contexts. While analysis of the organizational cultures of the large aerospace companies is not a primary focus of this research, their cultural influences still shape basic parameters of NASA-industry linkage creation and maintenance. For this reason, a brief description of "aerospace industry culture" will clarify what is to follow.

The organizational cultures of large aerospace companies embody a variety of distinguishing characteristics. Among these are the tendency for a significant proportion of personnel to have specialized backgrounds in aerospace and related engineering areas, business and finance, law, and other highly specialized disciplines. Additionally, aerospace company culture is characterized by structurally flexible and geographically mobile technical work groups for rapid response to contract

opportunities, elaborate administrative and managerial hierarchies for overseeing contract activities, and strong interorganizational network ties at all levels within the industry and government. The object is to "sell" to the government on a regular basis and in sufficient quantity to sustain the company's existence and its position within a competitive industry.

As with many other types of organizations, tension is often present between the technical R&D staff of scientists and engineers and the managerial staff as illustrated by the Challenger accident. Company engineers did not approve the launch because they lacked information about the performance of the rubber O-rings during cold temperatures. What little information they had suggested that cold posed a serious threat to the integrity of the joints.

The scanty and somewhat inconclusive scientific evidence from previous launches was not convincing to managers, however. Morton-Thiokol managers approved the launch despite the vigorous objections of the engineers. Management's decision was based on a different interpretation of the scientific information. Managers viewed the absence of conclusive evidence relating O-ring failure to cold temperatures as evidence for the absence of such a relationship.

One informant in this research who is an engineer stated in an interview that Morton-Thiokol engineers indeed

demonstrated a clear cause-effect relationship between cold temperatures and poor O-ring performance. He stated that engineers at NASA as well as at Morton-Thiokol knew that the operating specifications of the O-rings did not go as low as the ambient temperature on the day of the Challenger launch. He asserted that managers' approval of the launch under conditions outside the written performance specifications of the O-rings should have been grounds for criminal proceedings.

Management's decision reflected overriding concerns about Morton-Thiokol's image. The company was currently negotiating with NASA for renewing its ten-year, multi-billion dollar contract to produce the solid rocket boosters. A number of congressmen were pressuring NASA to reopen competition for the contract rather than simply extend Morton-Thiokol's award for another ten years. Estimated to be worth over $10 billion, the contract represented obvious benefits to other companies and their local and state economies. Further, questions still remained about awarding the original contract to Morton-Thiokol in the first place. Thus, Morton-Thiokol managers understandably wanted the contract to be extended; they did not wish to compete a second time with potentially hostile attitudes toward them present in goverment and in the aerospace industry (McConnell 1987, Rogers 1987).

The stakes were indeed high for Morton-Thiokol to maintain the existing linkage with NASA for solid rocket booster production. Managers feared NASA would interpret their decision to delay the launch as their inability to meet contractual obligations (McConnell 1987). Unfortunately, the decision to approve the launch in the interests of Thiokol-NASA linkage maintenance and resource stability resulted in a tragic loss of enormous proportion. Ironically, the very reputation company managers sought to preserve by the decision was greatly damaged. Thus, relations between managers and technical experts, the need to secure the company's threatened resource base, and concerns over company image are all illuminated by the Challenger tragedy.

Organizational cultures of aerospace companies, then, emphasize administrative, managerial, and technical flexibilities to respond quickly to NASA or other government agency contract and purchase order opportunities, to meet technical specifications and high quality demands for products and services, to compete successfully with other companies within the industry, and to maintain existing company-government linkage relationships. Since these companies also compete for contracts from other government agencies, such as the Department of Defense, interactions generally occur in traditional and predictable ways. Strong interdependencies between aerospace corporations and NASA,

as well as with other government agencies, reinforce industry orientations toward organizational viability through stable patterns of resource acquisition in the form of government contracts.

NASA's organizational culture, on the other hand, reflects the dominant themes of public accountability for resource allocation, resource acquisition that depends on successful manipulation of an extremely unstable political environment, "can do" attitudes toward technical problem solving, and pride in organizational achievements. These themes influence NASA's linkages with industrial organizations.

NASA, like all government agencies, must control its industry relationships to ensure that outcomes justify the resources allocated, to demonstrate that technical problems associated with their spaceflight and aeronautics programs can be solved, and to justify continued funding allocations from Congress. NASA must maintain sufficient power over its contractors to ensure cost-effective achievement of its goals and to overcome funding and other political threats to its continued survival.

Over time, NASA and aerospace company personnel have grown accustomed to one another's organizational cultures, and the interdepencies have strengthened. Evidence of the strength of the interdependencies is the tendency for NASA managers and administrators to turn automatically and

exclusively to aerospace companies for goods and services. It often does not even occur to NASA program managers to look beyond the aerospace industry for companies to provide goods and services.

The degree of interdependency is illustrated by two examples. One is found in NASA's Office of Space Station's charge to develop potential "users" of the space station facility. Since these "users" are ideally to be commercial companies, the space station program is also involved in the commercial development of the space environment. While not officially recognized by the more narrowly defined CUS programmatic elements within NASA, space station user development activities represent other interests in space commercialization. It is assumed that the space station must be as attractive as possible for potential user companies, or strong private sector support for its R&D capabilities will not materialize. Identification of potential user and supplier companies along with their requirements will enable space station engineers to design a facility that meets the needs of a wide variety of paying corporate customers both inside and outside the aerospace industry.

To this end, NASA contracted with several large corporations to develop commercial users for the shuttle and later for the space station. Of these, the principal contracting organizations were Booz-Allen and Hamilton and

Coopers Lybrand, both large consulting firms. Studies completed by these firms working independently, but simultaneously, were designed (1) to encourage greater involvement on the part of corporations in commercial space activities in general, and (2) to encourage interested companies to assist NASA in developing physical specifications and capabilities in the space station that would be of use and benefit to commercial users.

As a follow-on effort in 1987, the Office of Space Station contracted with the Boeing Aerospace Corporation and the accounting firm of Peat, Marwick, and Mitchell to develop nonaerospace commercial users for the space station. This three-year contract resulted in creation of the Boeing/Peat Marwick Commercial Space Group, a project team composed of technical specialists and business experts. The team's charter was to identify potential nonaerospace commercial users, encourage them to become involved with NASA, and assist them to negotiate agreements with NASA for additional commercial R&D experiments in the space environment or with ground-based NASA facilities and equipment.

The first companies approached by the team were large aerospace companies and other Fortune 500 companies with aerospace-related divisions. According to one informant, the rationale for approaching these companies was that only they have the necessary resources to consider doing work in

the space environment. "Resources," here refers to money and available expertise of the scientists and engineers who conduct a company's R&D activities. Smaller nonaerospace companies were not considered to be potential users, even though they were targeted by the program and are more likely to need advanced research capabilities in support of new materials, technologies, and other products.

During 1987 and 1988, the terms of the Boeing/Peat Marwick contract were modified by NASA to incorporate a broader spectrum of CUS program activities and to assist the project team in attracting larger numbers of nonaerospace companies. Complementarities were discovered between the goals of the space station project and the resources available through NASA's Office of Commercial Programs (OCP), chiefly its network of ten regional Industrial Applications Centers (IACs), and the contract was subsequently transferred to the OCP. The primary mission of the IACs is to transfer technology from NASA and the federal laboratories to the private sector for subsequent development and commercialization. Thus, IACs have large pools of contacts, particularly among small and medium-sized nonaerospace companies, the very companies targeted by the space station user development project.

The contract modifications required that a substantial training effort be developed to familiarize IAC representatives with the project goals. IAC representatives

were trained and given responsibility for "outreach," that is, communicating the potential benefits of NASA linkages for commercial space and space station activities to nonaerospace companies. Interested companies were to be referred to the Boeing/Peat Marwick team for assistance in negotiating linkage relationships with NASA.

However, even with continued hard work and utilization of the IAC network, the project team was unable to form linkages with a large number of nonaerospace companies. Most linkages were forged either between NASA and aerospace companies already intimately familiar with the potential benefits of early and sustained involvement with the program or with large corporations with active aerospace divisions, such as Johnson & Johnson (pharmaceuticals) and John Deere, Inc.

The second example of the strong interdependencies between the aerospace industry and NASA illustrates that the aerospace companies themselves are most eager to seek linkages under this program. That is, while the goal of the Commercial Space (CUS) Program is to encourage increased involvement of nonaerospace companies, it was the aerospace companies that immediately recognized the potential benefits from CUS involvement. Thus, the initial linkage agreements negotiated with NASA as part of the CUS program were with the aerospace companies and with other large corporations having aerospace-related divisions. For example, Johnson &

Johnson teamed with McDonnell Douglas to negotiate a Joint Endeavor Agreement (JEA) with NASA for pharmaceutical experiments aboard the space shuttle. Johnson & Johnson focused on the pharmaceutical aspects of the experiments, while McDonnell Douglas designed the experimental apparatus from its experience with previous equipment design for space flight. Similar agreements were signed between NASA and 3M, Boeing, and other aerospace corporations while other companies like the Ford Motor Co. and John Deere, Inc. explored ways in which their aerospace divisions could take advantage of CUS opportunities.

Thus, one major problem was that even within a program designed specifically to reach out to new types of companies, NASA program managers often turned first to their traditional aerospace partners for help, and the aerospace companies were first to perceive and capitalize on CUS program involvement. This is not to say that the aerospace companies should not be involved in CUS program activities, or that they cannot contribute valuable expertise and facilities to accomplish CUS program goals. Rather, the traditional interdependencies between NASA and the aerospace industry have hindered active solicitation of nonaerospace companies as mandated by the policy.

Even when agressive and visionary managers of nonaerospace companies seek out opportunities for involving their organizations in CUS program activities, they

encounter difficulties in communication and linkage negotiation. The trouble most often lies in the fact that NASA program managers often assume either (1) all companies act like aerospace companies and have the same degree of scientific and technical sophistication about space flight, or (2) (according to one informant) only the aerospace companies have the necessary scientific and technical expertise needed by NASA and are the standard by which nonaerospace firms are compared. In the latter case nonaerospace companies simply do not "measure up."

Further, NASA managers expect companies to accommodate NASA. After all, the aerospace companies always have adjusted their operations and work groups to meet NASA's technical, administrative and political needs. Companies adapt to NASA; NASA does not adapt to companies. The same is true for virtually all traditional linkage relationships between industry and government. New interorganizational linkage formats, as a consequence, must be forged amidst strong NASA-aerospace industry interdependencies and traditional patterns of interaction. The following section describes the new types of interorganizational linkages associated with the commercial development of space and the problems associated with their implementation in traditional NASA-industry linkage contexts.

Organizational Linkages Within the Commercial Use of Space (CUS) Program

In contrast to the traditional nonegalitarian NASA-industry linkage formats, linkages within the CUS program are much more egalitarian in nature. Rather than increase dependency on government purchase of goods and services for industry, CUS linkages encourage industrial organizations to recognize and capitalize on the potential benefits of the space environment for advanced R&D and other commercial activities. NASA's role in and control of many areas of potential commercial benefit will decrease as industry assumes primary development responsibilities. In keeping with this policy goal, CUS linkages stress joint responsibilities and allocate power more equally between NASA and the commercial partners that will ultimately commercialize and control many space-related activities.

The linkage relationships which characterize the CUS program provide for a wide range of NASA-industry interaction depending upon the nature of the work to be accomplished. These linkages are formalized by agreements, including the Memorandum of Understanding (MOU), the Memorandum of Agreement (MOA), the Technical Exchange Agreement (TEA), the Industrial Guest Investigator Agreement (IGI), the Joint Endeavor Agreement (JEA), the Space System Development Agreement SSDA), and the Launch Services Agreement (LSA).

The MOU and the MOA are formalized statements of intention to continue to explore grounds for mutual cooperation and activity. They are the most informal of the linkage arrangements and do not generally involve specifically defined sets of tasks for NASA and the industrial partner. They generally function as precursors to the more formal linkage agreements described below.

Technical Exchange Agreements (TEAs) provide for exchanges of technical information between NASA and an industrial organization. The information exchanged may derive from NASA's wealth of technical publications or from industry access to NASA experts and facilities. Designed primarily for experiments which focus on the effects of microgravity on materials processing, the TEA enables a company to access NASA facilities, such as drop towers and drop tubes, aircraft, and sounding rockets which provide from several seconds to several minutes of weightlessness in which to conduct experiments. No funds are exchanged in the context of the TEA. Rather, each participant assumes the costs of its part in the collaborative effort. Benefits of TEA-type linkages include the exchange of potentially valuable technical information, the exposure of the company to opportunities available within the space program, and increased NASA familiarity with the research and development resources and capabilities of the company.

Industrial Guest Investigator Agreements (IGIs) also involve a NASA-industry collaboration on a research project. The IGI linkage arrangement, however, provides for greater company participation in a NASA-funded experiment conducted during a space flight. Under such arrangements the company participates through direct involvement of one or more of its own technical researchers in the project. Again, no monetary exchanges are involved in this type of linkage. Each participant funds its own portion of the project.

TEAs and IGIs are designed to provide industrial organizations with access to NASA expertise, facilities, equipment, and other technical resources with minimal exchange of monetary obligations. They are designed to introduce industry to the available technical opportunities available within NASA and the space program in the hopes that the specific research projects involved will lead to more sustained activity on the part of the company. If more sustained involvement is attractive to the industrial organization as a result of a TEA or an IGI, other linkage mechanisms are available to accommodate the need.

Probably the most well known of the CUS linkage agreements is the Joint Endeavor Agreement (JEA). The JEA is an arrangement whereby a company and NASA jointly pursue a research project of interest to both. A significant difference here is that while there is no obligatory exchange of funds, a formal statement of the expected

benefits to accrue to NASA and its industrial partner is negotiated. Furthermore, the industrial organization is required by NASA to make every effort to develop and commercialize the technology or other outputs resulting from the research project.

In the base agreement, as in the TEA and IGI, each participant funds its own part of the work. The industrial organization develops an experiment or demonstration program, carries out the required ground-based research, and develops the flight hardware necessary to conduct the experiment in the space environment. NASA provides technical assistance and contributes from one to several free shuttle flights for the experiment. In addition, NASA ensures that the experimental package, or "payload," can be integrated with the electrical, computer, and other elements and systems of the space shuttle.

Joint Endeavor Agreements are somewhat constraining for the company in that while shuttle flights are free, the terms stipulate that the experiment must be designed to fit existing shuttle systems and performance capabilities. This means that in order to fly, the experiment must be designed to correspond to existing power, weight, heating and cooling, and other systems elements of the shuttle. Consequently, such experiments are generally limited in physical size as well as in technical and scientific complexity. Additionally, the experiment will be scheduled

for flight on a "space available basis," and NASA reserves the right to change the flight schedule to accommodate other payloads or to integrate a series of related experimental payloads on a particular flight.

Should the company wish to fly a more elaborate experimental package, optional services can be requested from NASA. These services may include the addition of specialized hardware, such as special brackets or wiring, extra days in orbit, astronaut tending of the experiment for a longer time period, or extra power needs. These optional services may result in a more sophisticated and/or meaningful experimental apparatus for the company, but they are not considered to be part of NASA's standard contributions within a JEA. The company must negotiate a separate agreement with NASA and pay for the costs of the added technical, labor, and/or launch services.

The Space Systems Development Agreement (SSDA) is centered around the development of space hardware, including vehicle components, equipment or other facilities for the shuttle, and related hardware. In contrast to the JEA, payment for launch services is required. However, an attractive feature of the SSDA is that payments by the company can be delayed or deferred, according to the circumstances and hardware being developed. Thus, a company is able to develop a potentially important, and ultimately profitable, piece of hardware in the space environment and

delay payments to NASA for launch services until the hardware can be sold or leased for profits. This is an especially attractive arrangement since launch costs total millions of dollars.

In an SSDA the industrial participant assumes the costs for its own researchers, experiment development, integration of the experiment into the shuttle, and evaluation of samples and research data. While the company eventually pays for launch services as well, there is an added incentive, in that the industrial partner also retains all proprietary rights to the technology developed.

The Launch Services Agreement (LSA) is a standard purchase agreement, with no concessions granted by either party. The LSA is simply the purchase of launch services by a company to fly an experiment or other payload into space. The company funds all of the research, equipment development and integration, data analysis, and pays NASA a negotiated fee to transfer the payload into the space environment. As stated in NASA's Joint Agreements Manual, "Industry pays for it all and gets it all."

CUS agreements reflect more egalitarian resource exchanges and decision-making power between NASA and its industrial partners. First, NASA and a company each underwrite the negotiated costs of their individual participation in a joint venture. Second, both parties also negotiate their relative decision-making power with regard

to project activities, including experiment design. NASA still makes final decisions regarding physical integration of the payload with other internal spacecraft systems and launch parameters, however, as safety and other launch criteria demand.

These agreements are designed to benefit both NASA and industrial organizations by encouraging more research and development leading to the commercialization of new products, materials, processes, technologies, and so forth, and by increasing the opportunities for industry to access the space environment as well as the government-owned sophisticated research facilities available through NASA.

A major incentive of these agreements is a company's proprietary rights to the outcomes of research efforts. That is, the commercial partner may choose to pursue a patent on some newly developed equipment, product, process, or other technology that emerges from the joint activities. Such patents can be highly significant sources of increased revenues by direct sales. Alternatively, patent holders can profit by negotiating licenses or other contractual arrangements for further development by other companies, especially "spinoff" companies formed to exploit the technologies developed by the parent company. Proprietary rights, then, are a direct benefit from CUS activities. As a consequence of new discoveries and inventions, proponents believe the CUS program will stimulate economic growth

through implementation of improved manufacturing processes on earth, introduction of new and improved products, and the creation and growth of new industries.

The program is also expected to alleviate many of the costs incurred by government in providing access to the space environment as well as in underwriting the costs of space science, flight hardware development, astronaut training, and other support activities. Since NASA's annual budget appropriations depend upon Congressional priorities, increased private sector cost-sharing and eventual private sector control of many space activities are seen as ways to decrease government's costs while maintaining the U.S. position as a leader in space. Besides this, the CUS program is seen as a way to increase economic growth and stabilize the country's position in international markets. This is because increased private sector involvement in space-based and space-related activities will result in lower costs for government support of the space program and in larger numbers of new products, processes, technologies, and other that will increase profitability.

Implementation of the commercial space program through new, more egalitarian linkage relationships depends upon overcoming the organizational congruencies and complementarities that have evolved between NASA and its traditional aerospace partners as well as between NASA and other federal government agencies. NASA may be forced to alter many of

the elements of its own organizational culture that have evolved in accordance with traditional interdependencies with the aerospace industry. These elements include several values and goals adopted throughout NASA, traditional relationships with Congress and other federal agencies, internal resource allocation patterns, perceptions about business and industry, and control over the terms and activities of NASA-industry relationships.

CUS linkages require changing the expectations on the part of executives of small and medium-sized high technology nonaerospace companies about the benefits of commercial space activities. Orientations of smaller companies toward strategic planning, decision-making, as well as toward acceptable time frames for R&D and returns on investments and sales differ from the orientations of large aerospace corporations. Neither the nature of and extent to which these differences affect linkage formation for CUS nor the effects of traditional NASA-industry linkage patterns on CUS linkage formation are well understood.

The central problem which emerges from the ethnographic context of the CUS program is that while CUS agreements are designed to be egalitarian and promote joint NASA-industry projects, the strong, traditional, nonegalitarian orientations of NASA and industry present a significant barrier to the creation of novel linkage formats. Chapter Five describes the problem more fully with special attention

to the small and medium-sized nonaerospace companies that NASA seeks as partners in CUS program activities.

CHAPTER FIVE

LINKAGES BETWEEN NASA AND NONAEROSPACE COMPANIES

Introduction

This chapter presents the findings from participant-observation, interviews, and survey responses from executives of small and medium-sized high technology companies. The results are presented in relation to the hypotheses discussed in Chapter Three and as they relate to the context and goals of the CUS program discussed in the previous chapter. The data were assembled and analyzed in several phases. The first phase involved simple proportional analyses and similar measures of association between and among variables. Data were aggregated and examined for significant differences during subsequent phases of the analysis. Appendix C contains the primary response data from the survey questionnaire.

The survey responses were tested for bias on three variables: geographic location, technology area, and company size as measured by annual sales revenues. These variables were selected to ascertain whether or not certain regional or geographic characteristics (such as proximity to a NASA field center), particular technology areas and industries

(such as robotics or lasers), or company size influenced the likelihood of responding to the questionnaire. No bias was found toward a particular geographic region of active high technology development, particular technology/industry area, or company size. Thus we conclude that the random sample accurately represents the universe of companies targeted by NASA for involvement in commercial space activities. However, non-high technology companies or large companies with annual revenues of over $100 million and/or over 500 employees were not systematically included in data collection, so the data are not generalizable to them.

Interviews with company executives, observations of company-NASA interactions in seminars and other CUS outreach events, together with data from the 403 (33%) usable responses to the national survey yield several generalizable characteristics of small and medium-sized nonaerospace companies which, in turn, provide a wealth of information for comparative purposes. The following section outlines the general characteristics of the sample respondents and describes elements shared to an extent that they can be categorized as the general characteristics of small and medium-sized high technology companies.

Organizational Culture of Small and Medium-Sized High Technology Companies

A primary objective of the research was to identify characteristics of nonaerospace companies that could

not only clarify the difficulties of creating linkages between them and NASA but also to shed additional light on cross-sector interorganizational linkages in general. As discussed in Chapter Three organizational culture is postulated to be the most important factor in linkage creation efforts between NASA and nonaerospace companies.

The uniqueness of any organization notwithstanding, there are similarities among various groups of organizations as discussed in Chapter Two. Business and industrial organizations all share similar orientations toward profits and growth, rely on fairly standardized procedures for decision-making relative to the development of goods and services for sale in the marketplace, and compete with industry rivals for customers. As we have seen, aerospace companies share a variety of similarities as a result of a history of interdependencies with NASA and other government agencies. But what about nonaerospace companies?

Putting the results together, a profile of the typical small to medium-sized high technology company emerges. First, the company is likely to be a manufacturer (68%), to employ fewer than 100 people (77%) and have annual sales revenues of less than $25 million (90%). Scientists and engineers account for less than 25% of the total number of employees (63%), and the company derives 10% or less of its annual income from government contracts (65%). Linkages

with government, then, are not a significant goal or activity.

As noted, the CUS program is designed to expand involvement of a broad array of nonaerospace industries. The program is a strategy to revitalize the U.S. space program as well as strengthen U.S. technology and economic development in general. A critical factor in technology development is R&D, since high technology is knowledge-intensive. Adequate and stable funding over time along with a staff of well trained scientists and engineers characterize successful high technology R&D programs. In fact, a major reason why companies are exploring linkages with universities and other organizations is to have access to the experts and the facilities necessary for costly and complex R&D activities. R&D is also a major focus of the CUS program, since access to the space environment, NASA facilities and critical knowledge are primary benefits from linkage formation.

Respondents were polled on the importance of a variety of R&D goals and activities in their companies. R&D activities include technology transfer, information research and literature reviews. These activities enable any company to achieve its own particular goals, such as discovering new knowledge, improving in-house operations, creating new or modifying existing products or services, and developing substitute products or services.

The nonaerospace high technology companies observed and sampled in this research utilize R&D to achieve corporate profits. R&D is not carried out for the sake of scientific and technical discoveries themselves, as in some R&D divisions of large corporations. Rather, R&D is undertaken to develop or improve products, improve operational efficiencies, and increase profitability. Not surprisingly, as shown in Table 5.1 (following page), company respondents reinforce this general orientation with their emphasis on the results of R&D efforts rather than on the processes, equipment, and facilities that enable the achievement of product- and/or efficiency-oriented R&D results.

Table 5.1 shows that achieving company goals is more important than the specific R&D activities necessary to meet the goals. Improving in-house operations (85.9%), modifying existing products/services (86.4%), and new product development (94.8%) are important goals that drive company R&D activities. Consequently, the means by which R&D is carried out is not as important for small and medium-sized high technology companies as it is for large corporations.

Large corporations generally have large R&D departments composed of numerous scientists and engineers. Long-term R&D projects designed to extend the frontiers of research in science and engineering are not uncommon, and company-NASA linkages for research provide excellent contexts for much of this activity. While corporate R&D is also oriented toward

Table 5.1: Importance of R&D in Sample Companies

R&D Goals/Activities	Importance of R&D Activities					
	Very		Somewhat		Not	
	n	(%)	n	(%)	n	(%)
Discovery of new knowledge	223	(55.3)	128	(31.8)	32	(7.9)
Technology transfer	162	(40.2)	170	(42.2)	44	(10.9)
Improve in-house operations	193	(47.9)	153	(38.0)	25	(6.2)
Information research	96	(23.8)	189	(46.9)	81	(20.1)
Modify existing products/services	191	(47.4)	157	(39.0)	38	(9.4)
New product/service development	320	(79.4)	62	(15.4)	11	(2.7)
Develop substitute products	102	(25.3)	174	(43.2)	97	(24.1)
Literature reviews	56	(13.9)	195	(48.4)	119	(29.5)

profitability, other company strategies create profits as well, such as sales or purchases of additional businesses for the corporate portfolio.

The small or medium-sized business, however, is much more dependent on the quickly ripening fruits of its R&D for profits and stability. Surprisingly, a large proportion (87%) of executives in small and medium-sized businesses listed 'discovery of new knowledge' as somewhat to very important. This indicates that the link between research (discovery of new knowledge) and new product development, e.g., the discovery of new superconducting materials, is widely understood and appreciated. Similarly, a large proportion (82.4%) of the respondents listed technology transfer as important. Technology transfer enhances R&D by providing access to new knowledge and technologies emerging

from basic research conducted in universities and in federal laboratories.

Thus, small and medium-sized companies are culturally distinct from the large aerospace corporations that traditionally link with NASA for space-related activities. In contrast to aerospace corporations described in Chapter Four, the small and medium-sized high technology company does not employ large proportions of scientists and engineers, has little government linkage experience, and utilizes R&D to achieve reasonably quick company profits rather than to make long-term investments in future discoveries and eventual new products. This last characteristic is especially important since linkage formation strategies within the CUS program emphasize the benefits of NASA facilities and expertise for carrying out long-term R&D projects.

Differences such as these are not enough in themselves to preclude linkage formation, however. Additional considerations are hypothesized to account for the difficulties encountered to date in creating and maintaining NASA linkages. The following sections illustrate these additional considerations.

Contrasting World Views

Linkage creation was hypothesized to be directly associated with the degree of knowledge on the part of the

members of one organization about the culture of the other organization (Hypothesis A). That is, linkages will be created more frequently if the potential partner organization is a "known quantity" and if the partner organization is felt to be congruent with or complementary to the initiating organization. Perceived congruence and complementarity of organizational cultures largely depends on how organizational culture is defined. As discussed in Chapter Two, one way to define organizational culture is the world view, or frame of reference, that underlies organization-specific values, goals, and operating procedures. Or it may be defined in terms of overt elements, including decision hierarchies and processes, organization of formal work groups, communication channels, and other observable characteristics.

Knowledge about a potential partner's organizational culture, then, involves perceptions of a consellation of elements. The analytical strategy focused on ascertaining the nature and scope of knowledge on the part of company executives on several variables, including perceptions about the other organization's world view, goals, mission, operations, and reasons for seeking linkage relationships.

Similarities and differences between company and NASA world views were noted often during interviews and participant-observation of CUS outreach seminars. These observed similarities and differences were then tested on a

wider scale via the survey questionnaire. The following paragraphs outline major findings and discuss their implications for the question of whether knowledge of the partner organization is a necessary and sufficient condition for linkage creation.

First, NASA orientations toward R&D emphasize the success of a given space mission and support of nationalistic scientific exploration. Space exploration, scientific discovery and technical problem-solving in support of spaceflight are primary goals and values. This view is reinforced by Congress and other federal political bodies which promote the image of NASA as an R&D organization. Managers who are long-time NASA employees share this orientation and have brought it to the CUS program.

Consequently, frames of reference differ between NASA/CUS representatives and the business leaders with whom CUS linkage relations are sought. These differing orientations are reflected in several instances and activities. For one thing, most presentations and outreach materials developed through the CUS program emphasize elements which can improve company R&D capabilities. Equipment, facilities, experimental conditions, and access to scientific and engineering experts are advertized by CUS personnel as the principal company benefits of company-NASA linkage creation.

However, the relationship between improved company R&D capabilities and their projected contributions to company profitability parameters is not explicitly presented. This is particularly evident in presentations focusing on materials processing in space (MPS) and, to a lesser extent, on remote sensing and the related area of earth and ocean observation. In most cases presentations are made by NASA researchers who are interested in developing experiments to be carried out and/or designing equipment to be tested in the space environment. While these individuals are well respected researchers and engineers, the scientific nature of their presentations dominates virtually all seminars, conferences, and training sessions, regardless of the levels of technical expertise held by the university, business, and/or government representatives in the audience.

Similarly, many written materials advocating the CUS program have been designed to appeal to scientific researchers. Written material focuses on such things as the physical characteristics of the space environment, the availability of sophisticated equipment throughout NASA, and detailed specifications of NASA equipment and facilities for scientific experimentation. These values do not generally appeal to business people even when their backgrounds are science or engineering. Their primary values and goals involve merchandizing products or services.

Incongruent frames of reference were observed in a number of NASA-sponsored CUS presentations to business and academic representatives. In one instance, during NASA's detailed technical description of a piece of equipment used in materials processing experiments on board the shuttle, a business person was overheard to say to a companion, "So what? It looks like a food processor to me. How do we make money with this?" On another occasion, a NASA CUS presenter was unable to provide satisfactory or relevant information about projected costs and benefits of potential product development, despite several attempts by the questioner and others in the audience to rephrase the original question. The NASA representative perseverated, continuing to provide ever more detailed technical and scientific data in response to what were obviously and quite pointedly market-oriented questions.

One informant, a NASA CUS program manager reported that the emphasis on scientific and technical features of space-based and space-related R&D is deliberate. This somewhat bizarre strategy is derived from experience with early targets of CUS outreach: engineers and scientists within R&D departments of large corporations. NASA assumes that if key R&D individuals are "sold" on the benefits of participation in space-related or space-based R&D activities, this will be expanded to convince upper level managers and decision makers of the benefits of linkages

with NASA. It should be noted, as well, that this has worked to NASA's advantage in larger companies and is therefore now an established part of NASA's own way of thinking and believing about business and industrial organizations and linkage creation.

Recently, this strategy has expanded to cover contacts with smaller business organizations that are not so likely to possess comparable R&D departments and budgets. While they may have scientific or technical backgrounds, executives in small and medium-sized companies do not appear to share the same concerns over experimental technique. Thus, while NASA's emphasis on technique and the advantages of the space environment and NASA facilities for improving technique may be a successful strategy for large corporations, it is not as well directed at the large numbers of smaller business organizations. In fact, industry audiences for CUS outreach presentations frequently appear to lack the knowledge to appreciate the relevance of technical information for their companies. When it is realized that the strong "bottom line" orientation of executives in small companies also does not correlate with the NASA's strong technical orientation, it is not surprising that miscommunication frequently occurs and results in no meaningful attempts at linkage creation on the part of business executives.

Survey data reinforced the observed communication mismatch. Company executives with no previous or current relationships with NASA were asked whether they had ever been contacted by NASA representatives to explore linkage creation opportunities. In those few instances (13 of 245 or 5.3%) when companies have been contacted by NASA, six executives (46%) indicate that they have a clearer understanding of potential opportunities for their companies with NASA, while seven (54%) report that they do not have any clear understanding. Reasons for this lack of clarity include perceptions that NASA presentations do not apply to characteristics of the company's primary industry (71.4%), presentations are not directed at the company products/services (57.1%), and NASA organization is difficult to understand (42.8%).

Executives of companies with no NASA linkages were also asked if they have ever considered the possibility of a NASA linkage. If so, have they followed up on the idea? Over half of the executives (53.8%) say the possibility has never occurred to them. The rest (46.2%) report having at some time considered a NASA linkage, but only 32.4% of those ever actually followed up on the idea.

The reasons for lack of follow-up are those most often cited by business people in earlier phases of the research. Variables include basic unfamiliarity with NASA (52.5%), negative stereotypes (such as too much "red tape") of NASA

and government (40.2%), overly lengthy negotiations of NASA agreements (24.6%), and cost/time/risk factors (7.9%).

A number of informants took the opportunity to go into more detail. Eight executives do not perceive congruence or complementarity between NASA and their companies' internal organizations, policies, experience, products, or services, while five others are unaware of NASA contracts, procedures and programs. One executive believes that the geographic location of his robotics company (in a midwestern agricultural state) is the reason NASA is not interested in doing business with him.

Taken together, survey data, interview responses, and observed NASA-company interactions indicate primary differences in world view, or frames of reference, between NASA CUS personnel and executives of small and medium-sized nonaerospace companies. These differences reflect primary distinctions between the values and goals of public versus private sector organizations. They also preclude meaningful communication and reinforce perceptions of incompatibility between NASA and small and medium-sized companies. In some survey questions, proportions are not more than good general indicators because the small number of respondents and multiple responses per respondent make careful interpretation impossible. However when coupled with the qualitative findings, the general idea is clear: very few companies have a clear picture of why they should link with

NASA. Thus, the findings support the hypothesized relationship between perceived interorganizational incompatibility and absence of linkage creation efforts.

Relationship Between Familiarity with NASA and Company-NASA Linkage Experience

Conflicts between NASA's mission to focus on basic scientific and engineering research and R&D related to spaceflight and executives' orientations toward profit were reinforced by other survey findings. Company executives were asked how familiar they were with the physical attributes of the space environment as well as a variety of space-related industries, some relevant NASA linkage agreements, R&D opportunities available through NASA, and NASA outreach programs. The responses from the survey are summarized in Table 5.2 below. Suffice it to say here that, in effect, respondents are largely unfamiliar with an extensive listing of NASA activities and relationships open to outside companies.

Attributes of the space environment describe physical conditions useful for scientific experimentation. These terms were included in the survey instrument because they appear throughout CUS outreach literature and are used extensively in CUS presentations to describe how CUS can increase company R&D capabilities. Of these characteristics, only solar radiation, the high and low

Table 5.2: Familiarity of Executives in Small High Technology Companies with R&D Opportunities with NASA and the CUS Program.

	Familiar (%)	Not Familiar (%)	N/R (%)
		(n = 403)	
ATTRIBUTES OF SPACE			
Microgravity	118 (29.3)	269 (66.7)	16 (4.0)
Solar Radiation	199 (49.4)	190 (47.1)	14 (3.5)
High/Low Temperature	238 (59.1)	154 (38.2)	11 (2.7)
Magnetic Field	173 (42.9)	216 (53.6)	14 (3.5)
Residual Atmosphere	104 (25.8)	285 (70.7)	14 (3.5)
High Vacuum	205 (50.9)	187 (46.4)	11 (2.7)
Extraterrestrial Vantage Point	75 (18.6)	315 (75.7)	13 (3.2)
Ionosphere	109 (27.0)	278 (69.0)	16 (4.0)
SPACE-BASED INDUSTRIES			
Materials Processing in Space (MPS)	153 (38.0)	232 (57.6)	18 (4.5)
Remote Sensing	204 (50.6)	182 (45.2)	17 (4.2)
Satellite Communications	191 (47.4)	196 (48.6)	16 (4.0)
Space Power	117 (29.0)	269 (66.7)	17 (4.2)
Propulsion Systems	104 (25.8)	283 (70.2)	16 (4.0)
On-Orbit Payload Processing	62 (15.4)	322 (79.9)	19 (4.7)
Life Sciences	133 (33.0)	254 (63.0)	16 (4.0)
Automation and Robotics	230 (57.1)	157 (38.9)	16 (4.0)
AGREEMENTS WITH NASA			
Prime Contract	132 (32.7)	253 (62.8)	18 (4.5)
Subcontract	179 (44.4)	208 (51.6)	16 (4.0)
Joint Endeavor Agreement	30 (7.4)	356 (88.3)	17 (4.2)
Memorandum of Agreement	40 (9.9)	346 (85.9)	17 (4.2)
Memorandum of Understanding	41 (10.2)	344 (85.3)	18 (4.5)
Launch Services Agreement	8 (2.0)	377 (93.5)	18 (4.5)
Technical Exchange Agreement	34 (8.4)	351 (87.1)	18 (4.5)
Industrial Guest Investigator Agreement	13 (3.2)	372 (92.3)	18 (4.5)
Range Use Agreement	7 (1.7)	377 (93.5)	19 (4.7)
Space Systems Development Agreement	8 (2.0)	377 (93.5)	18 (4.5)

Table 5.2 Continued:

	Familiar (%)	Not Familiar (%)	N/R (%)
R&D OPPORTUNITIES			
Centers for the Commercial Development of Space	39 (9.7)	344 (85.3)	20 (5.0)
Shuttle Flights	125 (31.1)	259 (64.3)	19 (4.7)
NASA Field Centers	96 (23.8)	288 (71.5)	19 (4.7)
Federal Laboratories	154 (38.2)	236 (58.6)	13 (3.2)
Small Business Innovation Research (SBIR) Program	226 (56.1)	163 (40.4)	14 (3.5)
NASA OUTREACH			
Commercial Use of Space Program (CUS)	111 (27.5)	276 (68.5)	16 (4.0)
Technology Transfer Programs	135 (33.5)	256 (63.5)	12 (3.0)
NASA Tech Briefs	216 (53.6)	176 (43.7)	11 (2.7)
NASA Spinoff	79 (19.6)	306 (75.9)	18 (4.5)
NASA Industrial Applications Centers	56 (13.9)	332 (82.4)	15 (3.7)
Space Station Activities	50 (12.4)	338 (83.9)	15 (3.7)
Small Business Innovation Research (SBIR) Program	226 (56.1)	162 (40.2)	15 (3.7)

temperatures, and high vacuum conditions are familiar to the majority of respondents.

Interestingly, less than one-third (29.3%) of all respondents were aware that the space environment is characterized by microgravity, that is, weightlessness. Microgravity is the term used in CUS and other NASA program materials to advertise one of the most attractive research conditions of the space environment. NASA's communication and marketing approach assumes that business executives have a higher level of familiarity about this characteristic

of space than they do.

Executives are no more familiar with space-based industries. As a rule, about half of the respondents are familiar with any given space-based industry. Fifty-seven percent (57%) of the respondents report at least some familiarity with automation and robotics as a space-based industry. This is not surprising given the large proportion of manufacturing firms represented in the sample whose normal activities cover these domains. Half (50.6%) of the respondents also indicate familiarity with remote sensing. However, satellite communications, the oldest and hardiest of the space-based industries is familiar to less than half (47%) of the respondents. Thus, even with respect to well established space industries, only half of the executives are aware of the range of things that can be done beneficially in space.

The only NASA agreements with which respondents are even slightly familiar are prime contracts and subcontracts. Even here, however, only about one-third (32.8%) of the respondents indicate familiarity with prime contracts. A higher proportion (44.4%) express familiarity with subcontracts. And, one in ten respondents is familiar with the Memorandum of Understanding (10.2%) and the Memorandum of Agreement (9.9%). Even fewer indicate familiarity with the Technical Exchange Agreement (8.4%) and the Joint Endeavor Agreement (7.5%), while fewer than 2% of the

respondents are familiar with each of the remaining agreement types.

Business executives are also unfamiliar with the last two categories in Table 5.2, R&D Opportunities and NASA Outreach. Significantly, the Small Business Innovation Research (SBIR) Program is well known both as an R&D opportunity and as part of NASA's Outreach program. This reflects the fact that the SBIR program spans many federal agencies, including NASA. The NASA Tech Briefs publication is familiar to over half of the respondents.

Thus, on the whole, executives of small and medium-sized high technology companies are clearly unfamiliar with the space environment, space-based industries, NASA agreements, R&D opportunities, and outreach programs. Further, this unfamiliarity is not associated with company size, company type or technology area.

Despite the generally low level of familiarity about NASA, it was expected that greater familiarity with NASA would be associated with presence of company-NASA linkages and that unfamiliarity would be associated with absence of company-NASA linkages. Since about 60% of the respondents report no previous or ongoing linkages with NASA, it was expected that their familiarity with NASA would be far less than for those executives with NASA linkage experience. Thus, comparisons were made between familiarity and unfamiliarity on the variables presented in Table 5.2 and

the frequency of company-NASA linkages reported by survey respondents.

Demonstrated associations between familiarity and NASA linkage experience were then selected for additional testing because of their relatively high Chi-square values. Additional testing concerned the strength of the association and whether familiarity was a good predictor of the existence of company-NASA linkages and vice versa. The results of these additional tests on the selected variables are shown in Table 5.3 below.

Table 5.3: Strength of Association Between Executives' Familiarity With NASA and Presence or Absence of NASA Linkage Experience.

Doing Business With NASA Associated With Knowledge About:	(n = 403) Chi-square ($p < .05$)	Phi-squared
Microgravity	18.86	.0488
High Vacuum	12.57	.0321
High/Low Temperature	10.14	.0259
MPS	14.91	.0388
Remote Sensing	12.53	.0325
Prime Contracts	63.84	.1663
Subcontracts	56.58	.1466
TEA	10.07	.0262
NASA Field Centers	41.55	.0283
Federal laboratories	46.57	.1197
SBIR	15.79	.0407
Tech Briefs magazine	38.27	.0979
CUS program	06.06	.0157

Table 5.3 reveals that despite an apparent association between familiarity with NASA and the likelihood of company-

NASA linkages, the association is actually quite weak. Further, familiarity with NASA is not a good predictor of the presence of linkages, and, conversely, the existence of linkages is not a good predictor of company executives' familiarity with NASA.

Most company respondents (61%) have no linkage experience with NASA, and the question of whether unfamiliarity with NASA is a primary factor was also investigated. Predictably, lack of NASA-company linkages is associated with unfamiliarity with NASA itself, procedures, R&D opportunities, linkage formats, and potential company benefits. What is surprising, again, is the weakness of the association between unfamiliarity and absence of company-NASA linkages.

To summarize, there is a relation as stated in Hypothesis A, but a weak one, between familiarity and company-NASA linkages. Linkages are not necessarily created because company executives are familiar with NASA, nor do they appear to result in greater familiarity with NASA. More importantly, executives' familiarity with NASA may lead to perceptions about organizational congruence or conflict. That is, it is entirely possible that familiarity with NASA reinforces perceptions about NASA-company incompatibilities leading to reluctance for executives to seek CUS or any other relationships with NASA. The following sections explore the question of whether or not perceived congruence,

complementarity, or conflict act as driving and constraining forces for NASA-company CUS linkage formation.

Process Versus Structure in Linkage Formation

Are linkages more likely to be formed if executives recognize process, or operational congruences or complementarities between their own company and NASA, or are structural factors, such as size, type of employees, or available resources important factors?[1] This is the question posed by Hypothesis B discussed and in Chapter Three. Answers to this question will further illuminate the influence of organizational culture on linkage formation, albeit utilizing definitions of culture that derive from the functionalist tradition. Here we are concerned with the compatibility of organizational processes as a driving force for linkage formation.

The question also enables examination of practical working assumptions on the part of CUS program personnel about which organizations are the likeliest linkage

[1] Use of the term "structure" refers to observable patterns of decision hierarchies, work groups, and internal demographic elements of an organization. While anthropologists largely reject the notion of structure or structural characteristics, the majority of organizational researchers, particularly those with sociological and psychological orientations, routinely utilize the concepts. As noted in Chapter Two, much of the literature on interorganizational relationships is devoted to identifying structural similarities among participating organizations as well as to describing structural characteristics of interorganizational communication and network patterns.

partners. These individuals assert that large organizational size and significant resource availability are the most important criteria for linkage creation within the CUS program. If other criteria appear to be equally or more influential for linkage creation, present CUS linkage outreach strategies and activities may be inadequate.

The data on this issue were assembled from both telephone interviews with business executives and from responses to the survey questionnaire. The analytic strategy called for collection of information about the general characteristics of companies that were or are linked to NASA as well as of those with no NASA linkage experience. Types of linkage relationships were also tabulated together with data about whether or not companies have made adjustments in their operations and/or internal formations in order to carry out linkage activities.

To start with, comparisons were made among companies that have and have not done business with NASA to see if particular sets of company characteristics are associated with linkages. Following the theoretical issues discussed in Chapter Three, types of companies were compared to types of linkage agreements as well as to the kinds of adjustments most commonly made by the companies. Because survey respondents frequently note more than one of the options on several of the questions, no sophisticated testing could be

done on certain cross-tabulations. However, the data support some important generalizations.

The following tables indicate the variety of companies that have and those that have not linked to NASA in terms of company type, company size, and employee mix. Table 5.4 illustrates the responses (including multiple responses) given by executives in the survey sample. The number of responses in Table 5.4 is larger than the total number of survey respondents (403), since many executives note that their companies are of two or more types.

Table 5.4: NASA Linkages According to Multiple Responses on Company Type

	Business With NASA?		
Type of Company:	Yes	No	Total
R&D	40 (43%)	53 (57%)	93 (100%)
Service	13 (25%)	38 (75%)	51 (100%)
Manufacturing	114 (41%)	162 (59%)	276 (100%)
Other	5 (14%)	31 (86%)	36 (100%)
Total:	172	284	456

If only those companies described exclusively as R&D, service, manufacturing, or other type are tabulated with whether or not they have linked with NASA, Table 5.5 emerges (following page). Table 5.5 illustrates that type of company is only weakly associated with doing business with NASA. Neither does knowledge of company type enable one to predict reliably a link to NASA. Linkage formation is not, then, related to whether a company is classified as manufacturing, R&D, service, or other type.

Table 5.5: NASA Linkages Compared with Single Responses on Company Type

Type of Company:	Business With NASA? Yes	No	Total
R&D	30 (46%)	35 (54%)	65 (100%)
Service	9 (29%)	22 (71%)	31 (100%)
Manufacturing	102 (43%)	137 (57%)	239 (100%)
Other	3 (14%)	18 (86%)	21 (100%)
Total:	144	212	356

[Chi-square = 9.016; p = .029; Proportional Reduction in Error (Tau) = .007]

Similar comparisons were made for company size, both in terms of number of employees and the size of the resource base as indicated by annual returns from sales. Tables 5.6 and 5.7 illustrate the findings.

Table 5.6: NASA Linkages and Company Size (Employees)

Company Size (employees):	Business With NASA? Yes	No	Total
1 - 99	112 (36%)	197 (64%)	309 (100%)
100 - 249	30 (49%)	31 (51%)	61 (100%)
250 - 500	12 (50%)	12 (50%)	24 (100%)
Over 500	2 (40%)	3 (60%)	5 (100%)
Total:	156	243	399

[Chi-square = 4.859; p = .18]

Table 5.7: NASA Linkages and Company Size (Sales)

Company Size (annual sales):	Business With NASA? Yes	No	Total
Less than $1 million	39 (32%)	83 (68%)	122 (100%)
$1 - $25 million	100 (42%)	140 (58%)	240 (100%)
$25 - $50 million	9 (47%)	10 (53%)	19 (100%)
$50 - $100 million	6 (46%)	7 (54%)	13 (100%)
Over $100 million	1 (25%)	3 (75%)	4 (100%)
Total:	155	243	398

[Chi-square = 4.424; p = .351]

Analysis of the relationship between company size as measured by number of employees and whether or not the company is or has linked to NASA reveals no association. However, when the data were aggregated into larger categories, there does appear to be a significant difference between companies with fewer or more than 100 employees, as shown in Table 5.8. As this table shows, companies with fewer than 100 employees are less likely to have done business with NASA.

Table 5.8: 2 X 2 Comparison of NASA Linkages and Company Size (Employees)

Company Size (employees)	Business With NASA? Yes	No	Total
1 - 99	112	197	309
100 or more	44	46	90
Total:	156	243	399

[Chi-square = 4.68; $p < .05$]

Similarly, when data on company size as measured by annual sales revenues is aggregated, only a weak association is revealed between companies with less than or more than $1 million and business with NASA as shown in Table 5.9:

Table 5.9: 2 X 2 Comparison of NASA LInkages and Company Size (Sales)

Company Size (sales)	Business With NASA? Yes	No	Total
Less than $1 million	39	83	122
More than $1 million	116	160	276
Total:	155	243	398

[Chi-square = 3.59; $p < .1$]

We can thus say with some certainty that with the exception of very small companies (fewer than 100 employees and less than $1 million in annual sales), company size is not a good predictor of past or present links to NASA. Consequently, except for the very smallest firms, company-NASA linkages are not related to overt structural characteristics, such as company size and type.

To see whether larger proportions of engineers and scientists were associated with NASA linkage experience, employee mix was compared to linkages with NASA. The results of these tabulations are presented in Table 5.10 below:

Table 5.10: Employee Mix Related to NASA Linkages

Proportion of Scientists and Engineers Among Employees:	Business With NASA? Yes	No	Total
Less than 10%	27 (25%)	79 (75%)	106
10 - 25%	69 (46%)	80 (54%)	149
26 - 75%	45 (41%)	64 (59%)	109
76 - 100%	17 (44%)	22 (56%)	39
Total:	158	245	403

[Chi-square = 12.05; p = .007; Proportional Reduction in Error (Tau) = .03]

Statistical tests for association for all of the categories presented in Table 5.10 above reveal an association, but neither linkage nor proportion of scientists and engineers is a good predictor of the other (Tau=.03 when NASA linkage was the dependent variable and

Tau = .01 when it was the independent variable). On the other hand, aggregating the data to explore the strength of difference between companies with 10% or less scientists and engineers and those with more than 10% scientists and engineers leads to a conclusion similar to that for linkages and company size. Table 5.11 demonstrates that there is a significant difference in the association between NASA linkages and proportion of scientists and engineers. If the proportion exceeds 10%, a NASA linkage is more likely.

Table 5.11: Employee Mix Related to NASA Linkages

Proportion of Scientist and Engineers Among Employees:	Business With NASA? Yes	No	Total
0 - 10%	27 (25%)	79 (75%)	106
over 10%	131 (44%)	166 (56%)	297
Total:	158	245	403

[Chi-square = 12; $p < .001$; Phi-squared = .03]

This finding suggests several things. First, NASA is an R&D-based organization populated largely by scientists, engineers, and other technical people. A more or less direct association between NASA linkage behavior and increased proportions (over 10%) of technical employees within private sector organizations indicates that "like is attracted to like." Second, from a practical perspective, NASA may wish to pursue linkage relationships with companies that have larger proportions of scientists and engineers among their employees. This is not to say that companies

with fewer than 10% will not link with NASA, but rather that a better rate of success is expected for linkages between companies with more than 10% technical employees.

Industry/technology area, however, does not appear to be associated with doing business with NASA as shown in Table 5.12:

Table 5.12: Technology Area Related to NASA Linkages

	Business With NASA?		
Technology Area:	Yes	No	Total
Artificial Intelligence	4 (44%)	5 (56%)	9
Automation	30 (49%)	31 (51%)	61
Biotechnology	4 (7%)	20 (83%)	24
Chemicals	4 (36%)	7 (64%)	11
Energy	6 (30%)	14 (70%)	20
Manufacturing	6 (32%)	13 (68%)	19
Advanced Materials	12 (39%)	19 (61%)	31
Medical	9 (45%)	11 (55%)	20
Pharmaceuticals*	0 (0%)	1 (100%)	1
Photonics and Optics	27 (44%)	34 (56%)	61
Technology Services	31 (40%)	47 (60%)	78
Testing and Measurement	22 (34%)	42 (66%)	64
Total:	155	244	399

[Chi-square = 10.46; df = 10; p > .3]
*Excluded from testing

Most of the technology areas in the Table 5.12 reflect the general trend for doing business with NASA, i.e., 40% yes and 60% no. Automation and artificial intelligence reflect almost an equal split between those companies that have and have not done business with NASA, while biotechnology, energy and manufacturing are weighted toward companies which have not done business with NASA (83%, 70%, and 68%, respectively). However, when the Chi-square test for

independence is conducted, the two variables, technology area and NASA linkage experience are independent. That is, doing business with NASA is not related to particular technology areas.

The above analyses strengthen the conclusion that linkages are not associated with company type. Nor are they associated with company size or proportion of scientists and engineers, except in the cases of the very smallest companies. In these cases it is reasonable to assume that very small companies are not promising linkage partners. The question then becomes, is there some minimum "critical size" that can be used to identify promising linkage partners? Again, the answer appears to be, "No," although further statistical comparisons with large (over $100 million) corporations is necessary for a definitive answer.

We now turn to an examination of whether or not congruence or complementarity between other organizational cultural variables, namely process and operational elements, are associated with linkage formation. Process and operational congruence and/or complementarity are inferred from data about the nature and extent of internal adjustments made by companies in order to link and/or to maintain linkages with NASA. That is, adjustments, or changes, made by companies in their operations and normal ways of doing business indicate a need to adapt to NASA for creating or maintaining an interorganizational linkage.

Thus, a large number of changes in company operations or procedures is inferred to indicate adaptation toward congruence or complementary processes and/or operations, while no change or a small number of changes indicates either existing congruence or complementarities or the fact that congruence or complementarity may be unnecessary.

While 157 companies reported NASA linkages, only 88 (56%) indicated that adjustments had been made in their companies in response to NASA's linkage requirements. The remaining 69 companies (44%) did not report making adjustments. Follow-up questions indicated that changes were not needed in the majority of cases because the linkage relationship merely involved supplying existing materials or hardware that are already in compliance with NASA or prime contractor specifications.

However, companies reporting internal changes made in response to a NASA linkage(s) often indicated changes in more than one area. Table 5.13 on the following page illustrates the types of operational and processual changes made by manufacturing, R&D, and service companies in order to create or to maintain linkages with NASA.

Adjustments were most often made by companies in quality control procedures, decision making procedures and resource allocation criteria. Additionally, adjustments were also often required in normal risk taking parameters and in general operations. These data reveal that almost

Table 5.13: Adjustments Compared with Company Type

	Type of Company (n=88)				
Type of Adjustment	R&D	Service	Mfg	Other	Total
Normal quality control procedures	2	1	19	2	24
Normal decision making procedures	5	2	13	2	22
Normal resource allocation criteria	2	1	16	1	20
Normal risk taking parameters	2	1	12	3	18
Normal operations	3	1	8	5	17
Proprietary rules	2	0	6	2	10
Strategic planning practices	1	1	8	0	10
Reward and incentive system	2	2	2	1	7
Work group organization	1	1	3	1	6
Chain-of-command	0	1	5	0	6
Licensing rules	1	0	3	0	4
Legal staff	0	0	2	1	3
Existing agreements with other companies	0	0	2	1	3
Other	2	1	8	2	13
Totals:	23	12	107	22	163

two-thirds (62%) of all adjustments reported require that the company deviate from normal procedures or operations if they wish to link with NASA. Thus, linking with NASA in some cases requires serious changes in the way a company works. NASA may be an attractive market for company products and services, but it requires some degree of interorganizational congruence or complementarity to exploit it.

While manufacturing companies account for the majority of companies that have done business with NASA, all companies have had to make adjustments to various aspects of their organizations and operations. Even though multiple responses preclude more sophisticated statistical testing, the results indicate clearly that doing business (linking) with NASA means major adjustments and changes for small non-aerospace advanced technology companies.

These findings are consistent with the fact that the majority of companies that have done business with NASA are manufacturing companies providing products and/or services to NASA through traditional linkage mechanisms. In these types of relationships, NASA generally determines the quantity and quality of the goods/services provided as well as the delivery and payment schedules. Thus, the company must make internal adjustments where necessary in order to carry out the terms of the prime contract, subcontract, or purchase order.

Volunteered survey comments and informant interviews reinforce the primary reasons noted above as well as provide some idea about whether company adjustments toward greater compatibility with NASA are viewed as positive or negative. One company executive noted that it took much longer to obtain contract approval than to negotiate a satisfactory technical program. Others concurred with the problem of lengthy time frames for buying cycles, procurement

processes, and payment for products delivered to NASA. These lengthy time periods necessitate company changes in budgeting and finance to avoid or to cope with resource shortfalls while waiting for payment from NASA.

On another note, one executive relates that compliance with NASA's Equal Employment Opportunity requirements would have required his company to designate fringe benefits, reduce salaries, and emphasize hiring based on EEO requirements rather than on the technical skills needed to do the work. Such drastic changes in hiring policies and reporting procedures are feared by managers who believe that the quality of company products will deteriorate across the board. In this case the company refused to make such changes and chose not to pursue future linkages with NASA.

In contrast, another executive related that his company's relationship with NASA resulted in better company definitions of goals and objectives. He clearly views the adjustments made in response to NASA's reporting requirements as a beneficial adaptation overall and plans to make the changes a permanent part of company planning and operations.

To conclude, industry-NASA linkages do not appear to be associated with particular company characteristics, such as company type and technology/industry area. Linkages also are not associated with size, annual sales, and the proportion of scientists and engineers, except in the very

smallest companies. Industry-NASA linkages do, however, require adaptations and adjustments to company operations, organizational formats, and standards.

Companies indicate that adjustments are required in a variety of operations areas to comply with NASA requirements, and, in some cases, company executives indicate that the costs of required adjustments are not worth the perceived benefits of the linkage relationship. In these cases, the companies have moved in directions which do not involve NASA as a linkage partner.

Unfortunately, it is not possible, given the available data to ascertain which particular process or operational adaptations are more essential for linkage success than others, or to determine the degree of change involved. It is reasonable to assume that some required changes are relatively minor, while others may be of significant magnitude. Participant-observation in specific companies, if possible, could indicate more clearly the nature and extent of company adaptations required to work with NASA or other government agencies and to determine the relative importance of particular types of congruence or complementarity for linkage success.

Understanding Potential Benefits of Linkage Relationships

It was hypothesized that linkages are established if all participants believe they can obtain benefits from the relationship (Hypothesis C). Benefits can take many forms depending on the type of company and the objectives of its executives. Increased profits, greater visibility, new products, expanded market share, new market niches, enhanced reputation, access to new technologies, and organizational stability are often seen as beneficial results of interorganizational linkages. Thus, benefits to be derived depend largely on an individual's or group's frame of reference, and can frequently mean different things to company executives, government administrators, project managers, and scientists.

More generally, examination of the hypothesized association between linkage creation and resulting organizational benefits provides another opportunity to test assumptions held by NASA CUS program personnel. Earlier, the assumption about who are the 'best' linkage partners, in terms of organizational size and resource base, was shown to be faulty, since there is no real association between these characteristics and the tendency to link with NASA.

Here, however, the hypothesis provides a more direct test of NASA CUS assumptions about how to encourage linkage creation. As discussed earlier, the current strategy of choice is to "sell" the idea of commercial space activities

to corporate scientists. They will in turn, it is thought, convince their own corporate decision makers to approve the activity and invest the necessary resources to carry out project tasks. Initial presentations made to scientists are technical in nature and are designed to excite their individual research interests by describing linkage benefits such as obtaining greater knowledge about the physics and chemistry of materials in microgravity or the technical challenges of designing experimental hardware.

While corporate scientists (as well as scientists in academia and in federal laboratories) often see these as beneficial outcomes, it has already been shown that other corporate decision makers do not agree. As presented earlier, our data show that, while R&D capability is considered important, most company executives evaluate profitability factors first. Consequently, unless the R&D scientist is able to recognize and communicate beneficial outcomes of commercial space activity in terms of profits to the company, it is unlikely that managerial and other corporate support will materialize.

To understand more clearly the linkage goals of business executives in small and medium-sized nonaerospace companies, data were collected about the relative imortance of linkage goals. For those companies linked to NASA in the past, information was also collected about whether or not the company's linkage goals had been met. If goals were

met, or in other words if company benefits accrued from the linkage, then it is reasonable to assume that company executives would be willing, even eager, to create additional linkages. If the goals of previous relationships were not met, then by the same reasoning it is logical to hypothesize that company executives will be reluctant to create new linkages unless beneficial results are clearly recognized and understood. And, therefore, greater hesitancy to link with NASA on the part of company executives can be predicted in such cases.

Finally, information was collected from companies with no previous or current NASA linkages to see if ideas about negative outcomes (or few benefits) were a significant rationale for the absence of linkages. If executives in these companies feel that outcomes are not beneficial then the hypothesized relationship between linkage formation and perceptions about resulting benefits will again be supported.

Table 5.14 (following page) presents the responses of executives with previous NASA linkages about the relative importance of a variety of possible and reasonable linkage goals. As this table shows, about half of the respondents felt that new product development and the development of NASA as a client or market were very important goals. Aggregating the very important and somewhat important response frequencies reveals that at least 75% of the

respondents view new product development and the development of NASA as a client/market as important. This is consistent with the fact that a large majority of respondents with previous company-NASA relationships are manufacturing companies concerned for developing new products for sale to government markets.

Table 5.14: Relative Importance of Company Goals in NASA Linkages (= 156)*

Goals	Very Important	Somewhat Important	Not Important
New product development	76 (49%)	40 (26%)	25 (16%)
Develop NASA as a client/market	84 (54%)	38 (24%)	19 (12%)
Improve existing products	51 (33%)	54 (35%)	31 (20%)
Conduct basic research	40 (26%)	30 (19%)	65 (42%)
Increase profit/returns	46 (29%)	42 (27%)	47 (30%)
Access new technologies and information	34 (22%)	57 (37%)	45 (29%)
Support U.S. space program	47 (30%)	50 (32%)	37 (24%)
Access NASA facilities and expertise for R&D	25 (16%)	35 (22%)	72 (46%)
Strengthen in-house R&D capabilities	39 (25%)	50 (32%)	47 (30%)
Secure seed funding for business start-up	18 (12%)	18 (12%)	97 (62%)
Improve the company's competitiveness	47 (30%)	45 (29%)	42 (28%)

*Percentages do not total 100% since non-responses to this question are not included. Between 8% and 11% of the 156 respondents did not answer the question. Non-responses are not equated with "not important" responses because of the ranked response categories.

Other very important goals include improvement of existing products, support of the U.S. space program, and improved competitiveness of the company. These goals also reflect corporate profitability objectives for long-term organizational stability. While support for the U.S. space

program illustrates a high degree of patriotism for U.S. activities in space, it also reflects profitability goals, in that many business executives believe that an active space program translates into active markets for government purchase of company products, such as equipment and component parts for spacecraft, launch facilities, satellite tracking, and data relay.

It is clear that many more respondents value profitability over goals of increased R&D or scientific capability. The latter are listed as very important by only one-fourth of the respondents. These goals include basic research (25.6%), strengthened in-house R&D capabilities (25%), accessing new technologies and information (21.8%), and accessing NASA facilities and expertise for R&D (16%).

These findings reveal that profitability standards are far more important measures of linkage benefits for executives of small and medium-sized high technology companies. Further, the profitability theme of these goals echoes the profitability themes executives' noted with respect to general R&D activities shown earlier in Table 5.1 (page 150) and observed in participant-observation. Ironically, current NASA CUS linkage creation strategies stress the goal of increasing R&D capabilities while ignoring the underlying profitability goals used by executives to define and evaluate the benefits of company-NASA linkages.

Now that the importance of various company linkage goals has been established, we can examine the extent to which the goals were met via company-NASA linkages. Executives were asked whether or not the goals they considered to be most important were met through their company's linkage to NASA. Half (78) of the 156 repondents report that very important linkage goals either were not met at all (38.5%) or were only partially met (61.5%). Table 5.15 indicates the proportion of those respondents who say that a goal was very important and for whom the goal remained unmet after the NASA relationship. Each proportion

Table 5.15: Important Goals Not Achieved in Reported Company-NASA Linkage Relationships

Goals:	Very Important	Not Met
New product development	76	28 (36.8%)
Develop NASA as a client/market	84	36 (42.9%)
Improve existing products	51	14 (27.5%)
Conduct basic research	40	12 (30.0%)
Increase profit/returns	46	10 (21.7%)
Access new technologies or information	34	9 (26.5%)
Support U.S. space program	49	9 (18.4%)
Access NASA facilities and expertise for R&D	25	9 (36.0%)
Strengthen in-house R&D capabilities	39	9 (23.1%)
Secure seed funding for business start-up	18	7 (38.9%)
Improve company competitiveness	47	11 (23.4%)

is based on the number of respondents who listed a particular goal as very important. Thus, while some numbers appear to be quite small, the proportion they represent may

actually be quite high, depending on the total number of individuals who see that goal as very important.

Inability to develop NASA as a client/market is the most commonly reported unmet, but very important goal (36 of 84 for 42.9%) followed by securing seed funding (7 out of 18 for 38.9%) and new product development (28 out of 76 for 36.8%). Interestingly, all of the linkage goals regarded as very important were reported as not met in the linkage by sizeable proportions of companies. No matter what the goal, there is a very real chance that it has not been met in the linkage relationship by those with real experience in such relations.

We now turn to the question of whether or not outcomes, that is, goals met or unmet, of previous NASA linkages affect decisions about pursuing additional NASA linkages. Table 5.16 presents the results of this comparison.

Table 5.16: Linkage Goal Achievement Related to Desires for Future Company-NASA Linkages (n = 126)

Were the Goals Met?	Intend to Pursue Additional Linkages With NASA? Yes	No
Yes	46 (95.8%)	2 (4.2%)
Partially	44 (91.7%)	4 (8.3%)
No	21 (70.0%)	9 (30.0%)
Total	111 (88.1%)	15 (11.9%)

[Chi-square = 12.69; df =3; p < .01]

Clearly, an overwhelming majority (88.1%) of the respondents state their desire to pursue additional linkages with NASA. This appears to be true regardless of whether

the goals of previous relationships were met or unmet. However, a significant proportion (30%) of executives whose most important goals were not met do not intend to pursue additional linkages with NASA. This indicates that failure to meet linkage goals dampens desires to link with NASA and encourages executives to choose other strategies to meet profitability goals.

Reasons for not wishing to pursue NASA linkages were provided by several informants and via solicited comments on the questionnaire. Cost factors are the most commonly cited reason for not pursuing NASA linkages: it is too expensive to market products effectively to NASA. One individual states that the low volume of his company's sales to NASA does not justify further attempts to develop linkages, and another's negative experience with NASA has led him to pursue linkages with space agencies in foreign countries rather than with NASA. Other executives indicate that they are not aware of any real opportunities and/or cannot satisfy specialized government (including NASA) requirements.

These reasons for not seeking additional NASA linkages reinforce company profitability goals. First, concerns over selling products to NASA reinforces the fact that most of the companies are involved in some form of manufacturing and that their executives emphasize profitable sales of products to government markets. Second, products and services must

comply with technical and quality specifications as well as NASA's complex procurement regulations. Thus, selling adequate quantities of goods to NASA within externally imposed technical and quality standards is often considered too costly, either in terms of a low volume of sales or in terms of correspondingly high costs of company adjustments necessary to meet NASA's technical and quality specifications. Other executives' decisions clearly reflect the impact of negative experiences in previous company-NASA linkage relationships.

To summarize so far, executives with companies having previous linkage relationships with NASA report that linkage benefits are those that directly reflect profitability, rather than R&D and/or research capabilities. Further, the data reveal that the chances for achieving linkage goals are not good. Nevertheless, most company executives with previous linkage relationships with NASA still wish to pursue additional linkages even when benefits were not derived from previous linkages. Such linkages, however, appear most often to involve manufacturing companies seeking to create or reopen avenues for the sale of products to NASA, rather than to embark on joint R&D projects as conceptualized by NASA's CUS program. This reflects not only the dominance of manufacturing firms with merchandizing goals that continue to view NASA (probably government in general) as an attractive market, but also the widespread

perceptions of industry-government linkages as 'buyer-seller' relationships.

Companies with no linkage experience were asked why they had not pursued such relationships in the past. This was done in order to see if perceived goal conflict influenced decisions not to pursue linkages. As already noted (pages 157-158), about half of the company executives report having never seriously considered such a possibility. The remainder replied that they had thought about it but never followed up on the idea.

Reasons varied. These include a perceived lack of NASA interest in purchasing their particular company products (17.3%), high cost of the relationship (15.6%), lack of protection for company proprietary interests (6.7%), and anticipated difficulties in working with a large government bureaucracy, e.g., no granting of exclusive patent licenses (4.5%). Thus, company executives with no NASA linkages appear to assume that company goals will not be achieved.

Of course, as discussed earlier, the reasons most often cited for no previous relationships with NASA are that company executives do not know how to access NASA (52.5%) and/or that they simply never thought about it before (38.5%). Consequently, at least half of all companies lack information and contacts with NASA. Despite this, however, it appears that anticipation of negative outcomes (i.e., not achieving company goals) has played a significant part in

executives' decisions not to link with NASA. More tantalizing is the belief that organizational incompatibilities inferred from fears over high costs of adaptations, constrain linkage creation and/or beneficial outcomes in linkage relationships. This implies that successful linkage creation between NASA and small and medium-sized high technology companies must address differing frames of reference and their corresponding definitions of "beneficial outcomes." It also means that organizational incompatibility is a potentially significant constraint on linkage creation as well as on the achievment of desired linkage goals.

Overall, it is difficult to say with certainty whether or not interorganizational linkages are more likely to be created if both parties clearly see that they will benefit from the relationship. Our data show that there is high interest among company executives with previous NASA linkage experience to pursue additional linkages, even when outcomes of previous linkages were unsatisfactory. But it is also clear that company executives with no previous NASA linkage experience are more concerned about the constraints presented by organizational incompatibilities on achieving their linkage goals.

Since the majority of all companies in the research project are involved with manufacturing, executives most often define linkage benefits as sales to NASA. However, in

the context of the CUS program, NASA is not interested in buying goods and services from the private sector. Rather, NASA is making available to industry ("selling") its expertise, facilities, access to the space environment, and other resources. Definitions of company benefits to be derived from company-NASA linkages in the CUS program are not yet adequately formulated; company executives continue to define benefits in terms of profitability goals.

Linkage History and Linkage Formation

Are linkages more likely to be pursued by an organization with a tradition of such interorganizational relationships? Conversely, are organizations less likely to pursue linkages if such relationships have never been experienced in the past? The simplest way to answer these questions is to see whether a higher number of company executives with a history of organizational linkages wished to pursue linkages with NASA than those with no history of interorganizational linkages. At the outset we expected that companies interested in creating linkages with NASA would have a linkage history and that companies with less interest would not have a such a history (Hypothesis D).

Almost three-fourths (72%) of the executives with previous NASA linkages wish to pursue additional linkages with NASA while 10% do not. Those with previous NASA links also suggest that it would be rewarding for other small and

medium-sized businesses to pursue linkages with NASA. Thus, a substantial majority of the company respondents with a history of NASA linkages desire to pursue additional ones, and feel that other companies should do the same.

Company respondents wishing to pursue additional NASA relationships also have a history of linkages with other government agencies. One hundred fifty (91%) of the 158 respondents with a history of NASA linkages indicate a history of linkages with other agencies as well, particularly the Department of Defense (86%) and the Department of Energy (54.7%).

However, when comparisons are made between companies with a history of linkages with other federal agencies and whether or not executives desired to pursue additional linkages with NASA, the following data emerges:

Table 5.17: Linkages with Other Federal Agencies Compared to Plans for Additional NASA Linkages

Plan to pursue additional NASA linkages?	Linkages With Other Agencies? Yes	No	Total
Yes	120	6	126
No	19	2	21
Total	139	8	147

[Chi-square = .793; df = 1; p > .3]

As this table reveals, linkage to other government agencies is not a factor in plans to pursue NASA links. Reasons include the fact that the majority of respondents are

manufacturing companies desiring to sell products to NASA and other federal agencies. Thus, even with no history of linkages, government is viewed as a prime market. Unfortunately, we found only eight companies with no linkages to other government agencies so that comparison is difficult. Unfortunately also, companies with no NASA linkage history were not asked directly whether or not they wished to pursue linkages with NASA, and so no straightforward comparisons can be made about interest in linkage creation on the part of companies with or without linkage traditions.

More illuminating however is the finding that while a number of companies (45%) have considered linking to NASA, the majority (62.2%) have never followed up on the idea. Reasons given for not following up (discussed in conjunction with Hypothesis A on pages 157-158) are explained by the fact that executives do not know how to go about accessing NASA. The implication here is that if company executives knew how, then they would have followed up on the possibility of linking with NASA. Either this is a polite excuse, or there is a real desire to develop interorganizational links with NASA. There is no reason to suppose anything but frankness based on other responses to the questionnaire and in telephone interviews.

Whether or not companies without a NASA linkage history routinely link with other federal agencies is also unclear.

However, one indicator of linkage formation attempts with other government agencies is the submission of proposals for Small Business Innovation Research (SBIR) grants. Thirty-one percent of the 245 companies with no previous NASA linkage history have submitted SBIR proposals to a variety of other federal agencies, notably the Department of Defense (48.6%) and the National Institutes of Health (33.8%). Of these, only 8% (19) have submitted SBIR proposals to NASA. Of these 19 companies, only three report winning NASA SBIR grants, and these, significantly, do not consider themselves to have had a linkage to NASA. This indicates that the companies believe that "doing business," that is, `buying and selling,' is the basis for organizational linkages.

Such attitudes are also significant since SBIR activities are often included in NASA's CUS program linkage options. This is because SBIR grants are designed to support R&D leading to development of a new product or technology. Since the government defines the type of products/technologies it needs, the program still retains elements of traditional industry-government relationships while encouraging R&D rather than sales.

SBIR proposal activity was compared to company characteristics, specifically company type and number of employees. These comparisons were made in order to identify any other features of SBIR proposal activity that influence the association between consideration of company-NASA

linkages and history of SBIR relationships with NASA and/or other federal agencies. The results of these comparisons are presented in Tables 5.18 and 5.19.

Table 5.18: SBIR Activity by Company Type (n=239)

	Submitted SBIR Proposals?		
Type of Company	Yes	No	Total
R&D	27 (79%)	7 (21%)	34
Service	7 (32%)	15 (68%)	22
Manufacturing	24 (18%)	112 (82%)	136
Other	16 (34%)	31 (66%)	47
Total:	74 (31%)	165 (69%)	239

[Chi-square = 48.83; df = 3; p < .001]

Table 5.19: SBIR Activity By Company Size (employees)

	Submitted SBIR Proposals?		
Size of Company	Yes	No	Total
1 - 99	62 (32%)	130 (68%)	192
100 and up	8 (19%)	34 (81%)	42
Total:	70 (30%)	164 (70%)	234

[Chi-square = 2.23; df = 1; p > .1]

As one would expect, SBIR proposal activity is more prevalent among small companies classified generally as R&D, than it is for larger companies classified as manufacturing, service, or other, even when "other" includes companies with elements of all three categories. This finding is consistent with the nature and purpose of the SBIR program, namely government encouragement of new technology development on the part of smaller companies to meet the technology needs of government agencies.

SBIR proposal activity was compared to whether or not executives had considered seeking linkages with NASA. Table 5.20 presents the results of this comparison:

Table 5.20: SBIR Activity and NASA Linkage Consideration

		Submitted SBIR Proposals to Other Agencies?		
Considered Doing Business With NASA?		Yes	No	Total
	Yes	46 (41%)	65 (59%)	111
	No	28 (22%)	99 (78%)	127
	Total	74	164	238

[Chi-square = 10.42; df = 1; p < .01]

Table 5.20 shows that companies which have never considered doing business with NASA are less likely to have submitted SBIR proposals to any other federal agency. Also companies with SBIR proposal experience are more likely to have considered a linkage with NASA. Consequently, SBIR activity is a general, but not necessarily reliable, indicator of companies with some interest in a NASA linkage.

To summarize, the presence of a linkage history does appear to be related to desires to pursue additional relationships, although inadequacies in the survey instrument and unsatisfactory follow-up interviews preclude thorough investigation into this hypothesis at this time. Only the most general inferences can be made, based on the survey data. However, when this question is considered in light of the qualitative findings, there does appear to be a relation between linkage history and intent to create

additional linkages. Here, however, the linkage history is not so much that of an individual company. Rather, the linkage history which has become institutionalized into the 'buyer-seller' format appears to exert a great deal of influence on linkage creation decisions. That is, decisions to pursue or not pursue linkages are based on decision makers' perceptions about whether or not their companies are already compatible with NASA or whether or not they can earn a profit in the context of traditional relationships.

Previous Linkage Outcomes and New Linkage Formation

Earlier, we found that linkage creation is somewhat related to whether organizational decision makers think their organizations will benefit from the relationship (Hypothesis C). That is, linkages will be sought if decision makers visualize direct benefits to their organizations as a result. However, diverse definitions of "benefits" together with executives' fears that organizational incompatibilities will constrain the achievement of desired benefits influence whether or not linkage are sought.

We have also explored the question of whether or not a history of interorganizational linkages is a driving force for seeking new or additional linkages (Hypothesis D). Again, the data suggest that organizations with linkage experience are more likely to seek new or additional

linkages, but definitive relationships are still open to question. Additional factors appear to influence linkage creation decisions on the part of business executives.

Here, we examine whether or not good and bad linkage experiences influence decisions to create new or additional linkages. It was suggested (Hypothesis E) that negative linkage experiences would result in reluctance to create new or additional linkages, while positive experiences would result in eagerness to create new or additional linkages.

Positive experiences can be defined in three ways. One is when linkage goals are met for all participants. Another is by ascertaining whether important elements of the relationship, such as communications, operations and procedures, organizational formats, resources, etc., are a source of benefits outside or in addition to the original goals of the linkage relationship. Third, positive experience can be relatively defined by comparing the linkage experience with one agency to linkage experiences with other organizations.

Data about the positive and negative qualities of past linkage experiences were collected and assembled from survey responses and from interviews. First, positive experience defined as goal achievement has already been discussed. Tables 5.14 through 5.16 (see pages 183-186) reveal that positive versus negative outcomes of previous NASA relationships only slightly alter executives' desires

to pursue additional NASA relationships. The findings suggest that NASA linkages are desirable to most company executives who hope to develop the agency as a client or market for company produced goods and services. In only a few cases were company experiences so negative that executives have decided never to pursue additional NASA linkages.

Second, positive experience as defined by improvements to internal organizational elements was examined. Executives with NASA linkage experience were asked their opinions about the influence of each of 23 organizational and environmental factors on linkage outcomes as well as whether these influences were positive or negative. These responses were then compared to those same executives' plans to pursue additional NASA linkages. Table 5.21 (following page) presents the responses of these executives for each variable. The 23 variables have been grouped into six areas of organizational culture, namely resources/costs, decision-making procedures, attitudes, environmental factors, operations, and history. The table shows how the variables rated "most important" were viewed in terms of their positive or negative impacts on the linkage experience. Because of the multiple responses on each variable, no sophisticated testing of significant differences is possible, however trends do appear with regard to the type of effects of these variables.

Table 5.21: Influences of Organizational and Environmental Factors on Linkage Experience (n = 157)

	Type of Effect (%)			
	Positive	Negative	No effect	Total
Decision-making				
Agreement negotiation	8 (31)	4 (15)	14 (58)	26
NASA decision-making	8 (21)	19 (49)	12 (31)	39
Government red tape	1 (3)	26 (68)	11 (29)	38
NASA proposal review	19 (49)	9 (23)	11 (28)	39
Company decision-making	12 (63)	3 (16)	4 (21)	19
Total:	48 (40)	61 (38)	52 (32)	161
Resources/Cost				
Insurance coverage	1 (33)	1 (33)	1 (33)	3
Access to the space environment	4 (67)	1 (17)	1 (17)	6
Flight scheduling	3 (60)	2 (40)	0	5
No. of flights available	1 (25)	3 (75)	0	4
Access to NASA field centers	9 (75)	0	3 (25)	12
Cost to the company	15 (34)	11 (25)	18 (41)	44
Patent licensing issues	3 (27)	2 (18)	6 (55)	11
Company R&D resources	22 (56)	7 (18)	10 (26)	39
Total:	58 (47)	27 (22)	39 (31)	124
Environment				
Success of prime contractor	22 (69)	4 (13)	6 (19)	32
Activities of competitors	5 (18)	11 (41)	11 (41)	27
Unforseen market shifts	1 (07)	8 (57)	5 (36)	14
NASA Industrial Applications Centers	2 (33)	0	4 (67)	6
Total:	30 (38)	23 (29)	26 (33)	79
Attitudes				
Attitudes of NASA representatives	35 (67)	8 (15)	9 (17)	52
Attitudes of company stakeholders	4 (50)	2 (25)	2 (25)	8
Total:	39 (65)	10 (17)	11 ((18)	60
Operations				
Adjustments to normal company operations	3 (25)	0	9 (75)	12
Company-NASA communications	15 (50)	5 (17)	10 (33)	30
Capabilities of the Joint Endeavor Mgr	1 (20)	0	4 (80)	5
Total:	19 (40)	5 (11)	23 (49)	47
History				
Previous company experience with NASA	15 (60)	3 (12)	7 (28)	25
Total:	15 (60)	3 (12)	7 (28)	25

Table 5.21 shows that the five decision-making variables were characterized collectively as "most important" 161 times, followed by the eight resources/costs variables (124 times), the four environmental variables (79 times), the two attitude variables (60 times), the three operations variables (47 times), and the single history variable (25 times). While decision-making variables are most often considered most important linkage factors, responses varied as to whether the individual variables positively or negatively affect NASA linkages. Agreement negotiation and NASA's proposal review processes are positive influences, while NASA's decision-making procedures and government red tape more often are negative influences. Consequently, executives value and support decision processes leading to linkage creation, but, not surprisingly, they tend to dislike decision processes concerned with linkage maintenance.

Resource/cost factors considered "most important," including financial cost to the company and company R&D resources, exert slightly more positive than negative influences on linkage outcomes. Interestingly, while several other of these variables are noted as most important, they are not seen as having an effect on the linkage relationship. Further, NASA resources are not considered to be very important at all, despite NASA efforts to market CUS linkages in such terms.

On the whole, the organizational environment positively influence company-NASA linkage relationships. Success of the prime contractor is generally a very important positive influence on linkage activities, while activities of competitors and unforseen market shifts are negative influences. These responses reflect the preponderance of traditional prime contract, subcontract and purchase order formats for company-NASA linkages. Subcontractors, especially, are dependent on the successful activities of prime NASA contractors, and companies supplying goods and services to NASA via purchase orders are sensitive to unforseen changes in such markets for their products.

Finally, operations variables taken together either positively influence linkage relationships or have no effect at all. This means that companies either are already compatible with NASA for linkage activities, or the linkage does not impact company operations at all. Additionally, attitudes of NASA representatives are an important and very positive influence on linkage activities as is a history of previous NASA linkage experience.

Several informants expanded on the nature of company benefits in this context. One reports that his company was forced to utilize the breadth of its business and technical skills, and the result has been higher productivity, higher quality, and increased satisfaction of employees. Another states that his company's goals were broadened, and three

others note that their NASA linkages enabled their companies to pursue research and to develop new technologies that promise a variety of future benefits.

Finally, positive experience as defined by comparisons with linkages to other federal agencies was explored. Company executives were also asked to compare their NASA linkage experiences to their experiences with other federal agencies. This was done to ascertain whether NASA linkage experiences are significantly different or unique in any way from other industry-government linkage experiences. It was also done to ascertain the extent to which companies seek linkages with government agencies in general.

The findings show that 91% of the companies with NASA linkage experience have also linked to other government agencies. Of these other agencies, 86% had linked with the Department of Defense, 55% with the Department of Energy, and 43% with the Federal laboratories. Other government agencies to which the companies have linked are the National Institutes of Health (29%), the Environmental Protection Agency (24%), the Department of Transportation (23%), the National Science Foundation (23%), and the Department of Health and Human Services (9%). Significantly, NASA linkage experiences are ranked the same as or slightly better than linkage experiences with a wide array of other government agencies. Thus, companies with NASA linkage experience also have experience with other federal agencies and do not see

NASA as particularly unique. Linkage experiences with NASA are no better or no worse, on the whole, than linkage experiences with other federal agencies.

This finding has implications for the hypothesized relationship between linkage formation and organizational congruence, complementarity, and conflict. The fact that company linkage experiences with federal government agencies are generally about the same implies that at least some degree of congruence and compatibility is already present. That is, once a company links with one government agency, adaptations made can apply to links with other agencies. The fact that there are no significant differences in linkage experience with NASA and other federal agencies also indicates that the majority of linkage formats are similar.

Thus, positive linkage experiences are variously defined as goal achievement (usually measured by profitable sales to NASA), as improved company decision-making processes and operations, and as they compare with linkages to other federal agencies. On the whole, most companies report positive experiences, but specifics vary. Further, positive experiences encourage subsequent linkage formation as revealed in informant interviews.

Comments from executives with positive NASA linkage experiences reflect the desire to sell more company products to NASA. That is, they look for more purchase orders and seek ways to introduce new products to NASA. At least six

executives note their companies' products are of use to NASA and the space program. Several others say their primary customers are NASA prime contractors. Still others indicate a number of company benefits by working with NASA, including access to NASA facilities for R&D purposes, advancement of company technology with the consequence of more widespread industry use of that technology, and the fact that previous NASA relationships provided a key funding source for R&D. One informant reports that he just enjoys working with individuals in the context of the space program.

Most company executives with NASA positive linkage experiences recommend that other companies seek relationships with NASA (76%). Comments include beliefs that 'NASA is straightforward,' 'bills are paid on time,' and 'it is a "comfortable" experience.'

Even when the experience has mixed results, comments are generally encouraging. One executive warns that it is hard to start, but "OK after you learn how." Another states that although NASA is a knowledgeable customer, it is difficult to understand NASA's organization. Thus, once organizational congruence or complementarity is achieved, linkages are easier to establish. In contrast, five executives advise that other companies should not work with NASA unless they have something unique to offer.

Comments by individuals who did not recommend that other companies pursue NASA linkages are more revealing.

One company president states, "It's a one-in-a-million chance, compared to the big contractors. You need to know somebody." Other comments reflect frustration with resource acquisition and costs. These reactions include a number of views. Profit margins are too small, payments for products too slow, indeed funding in general is uncertain, and there is poor continuity between contracts, long intervals without funding, and it is difficult for small-medium sized firms to compete with large businesses. One executive also noted that in his own view, NASA is more comfortable with its older linkages and linkage partners than with new ones created with new companies.

Negative NASA linkage experiences, as expected, appear to be correlated with reluctance to pursue additional linkages with NASA. Company executives with no desire to pursue additional NASA linkages state that financial cost to the company is a principal factor. Cost factors include perceptions that company sales revenues from NASA are too low and that it is too expensive to pursue for small companies. One executive reports that his company has insufficient resources to do an adequate marketing job within NASA, a task he regards as necessary for winning a contract. Other reasons provided include difficulties of satisfying NASA's specialized requirements and no awareness of existing opportunities. One executive states that such linkages would be desirable only if they coincide with his

company's business plan format. In other words, he has no intention of adapting his company's procedures, organization, operations, or goals in order to become more congruent with NASA.

It appears from these comments that negative experiences related to costs of organizational adaptation toward congruence or, at least, complementarity with NASA, coupled with anticipated low returns, or profits, are primary reasons for not seeking additional linkages and for discouraging other companies from linking with NASA as well. In contrast, positive experiences, particularly with regard to company R&D benefits, previously comfortable relationships, and existing compatibility with NASA, are primary reasons for pursuing additional linkages and recommending that other companies seek linkages.

Overall, both qualitative findings and survey responses reflect the dominance of traditional 'buyer-seller' linkage formats between NASA and companies. Companies are "looking for purchase orders" and developing products useful to NASA, the space program, and ultimately to other industrial concerns. Surprisingly, R&D benefits to the companies is cited frequently by company presidents as an important but unanticipated and unsought positive outcome. Thus, even within the context of traditional linkage patterns, developing products in accordance with NASA specifications

requires maximum development of human resources, production technologies, and management skills.

Traditional Versus Non-Traditional Linkages

It was hypothesized in Chapter Three that the members of an organization will seek out relationships that are similar to past relationships (Hypothesis F). In other words, companies with a history of NASA purchase orders will continue to seek purchase orders in the future. Conversely, this hypothesis suggests that new types of relationships are not sought if they are significantly different than previous relationships because they will require adaptation toward new types of organizational congruence or complementarity.

This hypothesis required a fairly straightforward test comparing the types of previous company-NASA linkages with the types of linkages sought by company executives. As we have seen, 158 (39.2%) of 403 company executives report that their companies have been or are currently linked with NASA, primarily via purchase orders for products (53.7%), subcontracts (46.2%), prime contracts (36.7%), and SBIR awards (15.8%). Agreements associated with the CUS program do not form any appreciable portion of company-NASA linkages. Memoranda of Understanding (MOUs), Technical Exchange Agreements (TEAs), and membership in a Center for the Commercial Development of Space (CCDS) are held by only one or two respondents in each case. None of those sampled

report an Industrial Guest Investigator Agreement (IGI), a Space System Development Agreement (SSDA), a Joint Endeavor Agreement (JEA), or a Range Use Agreement (RUA) with NASA.

What this means is that traditional prime contracts and subcontracts linked through purchase orders are the linkages most commonly held by the responding companies. In this sense these companies link up to NASA as they do to other commercial and government organizations, overlooking or refusing to participate in unfamiliar and non-traditional forms of relationship. Table 5.22 shows the types and number of a variety of linkage formats as reported by R&D, service, and manufacturing companies:

Table 5.22: Company-NASA Agreements By Company Type

	Type of Company (n=157)		
	R&D	Service	Mfg
Type of Agreement			
Prime Contract	15 (28%)	6 (46%)	34 (20%)
Subcontract	12 (23%)	3 (23%)	50 (29%)
Memorandum of Understanding (MOU)	1 (02%)	--	--
Technical Exchange Agreement	1 (02%)	--	1 (.5%)
Center for the Commercial Development of Space (CCDS)	--	--	2 (01%)
Small Business Innovation Research Grant (SBIR)	13 (25%)	4 (31%)	7 (04%)
Purchase Order	8 (15%)	--	70 (40%)
Other	3 (06%)	--	10 (06%)
Total*:	53 (101%)	13 (100%)	174(100.5%)

*Totals exceed 100% due to rounding.

As Table 5.22 shows, manufacturing companies report that 89% of all agreements with NASA are prime contracts, subcontracts, and purchase orders. When these more traditional agreements are compared with other, more innovative agreement types associated with the CUS program, traditional formats clearly dominate company-NASA linkages, as shown in Table 5.23:

Table 5.23: Traditional Vs. Nontraditional Agreements

	Type of Company			
Agreement Type	R&D	Service	Mfg	Total
Traditional: (Prime Contracts, Subcontracts, and Purchase Orders)	35 (66%)	9 (69%)	154 (89%)	198 (83%)
Nontraditional: (MOU, TEA, CCDS, SBIR, and Other)*	18 (34%)	4 (31%)	20 (11%)	42 (17%)
Totals:	53	13	174	240

*See Table 5.22 for full titles.

Interestingly, even R&D companies indicate a high proportion of traditional linkage formats, although the total proportion (66%) is smaller than for manufacturers. By the same token R&D companies account for almost half (43%) of all nontraditional company-NASA agreements. These findings reflect the facts that 1) the newer, nontraditional linkages commonly associated with the CUS program emphasize research and development, not sales and profits and 2) companies with strong R&D components and/or missions are the

likeliest participants in CUS and other innovative programs,such as the SBIR program.

One-fourth of the agreements between NASA and R&D companies were SBIR awards in comparison to only 4% for manufacturing companies. SBIR relationships differ from traditional prime contracts, subcontracts, and purchase orders because they focus on research activities leading to product or technology development. However, even here, SBIR winners often hope that government will be a primary customer for technologies and products developed via the SBIR program.

In order to determine whether certain types of companies are more likely to conduct particular types of activities in their relationships with NASA, the following comparison was made:

Table 5.24: Linkage Activities According to Company Type

Type of Activity	Type of Company (n = 156)				
	R&D	Service	Mfg	Other	Total
R&D	29	7	28	6	70
Services	11	4	10	6	31
Hardware	12	3	125	13	153
Business Development	5	0	6	0	11
Other	3	0	9	1	13
Total	60	14	178	26	278

Table 5.24 shows that company type is related to type of activity as reported by company respondents. The majority of NASA linkage activities involve hardware. Provision of hardware to NASA accounted for 153 (54.8%) of the 278 activities noted by survey respondents, while R&D accounted for 70 (25.1%) of the activities. Manufacturing companies accounted for 70.2% of the hardware-related activities and are likely to have types of agreements through which hardware can be developed and sold to NASA. R&D companies account for almost half (48.3%) of the R&D-related activities and are more likely to have agreements such as Small Business Innovation Research awards, Technical Exchange Agreements, and Memoranda Of Understanding.

Statistical tests of association were not possible with these data, since many respondents indicate more than one type of agreement with NASA or more than one activity for each type of agreement. Nevertheless, the findings are consistent with expectations that the type of agreement negotiated will reflect type of company, the activity for which the company is organized and the existence of congruent or complementary organizational elements between the companies and NASA.

Implications are that companies do indeed visualize and seek future relationships with NASA that are similar in form and purpose to their previous or existing relationships. This is true whether or not company executives actually wish

to pursue additional relationships with NASA. Thus, companies with a history of purchase orders are eager to obtain more purchase orders in the future. The experience is overall a satisfying one. Even companies that do not desire additional NASA linkages do not visualize new types of NASA relationships with different rules, operations, goals and outcomes. Rather, they judge the benefits of new linkages on the basis of traditional formats.

Organizational Culture and Linkage Maintenance

So far we have focused on whether or not perceptions about organizational congruence, complementarity, or conflict significantly influence executives' decisions to establish linkages with NASA. The findings indicate that linkage formation does appear to depend on the degree of existing congruence or complementarity particularly in terms of costs and benefits of organizational adaptation to meet NASA requirements as understood for traditional 'buyer-seller' relationships. Now we turn to a consideration of the effects of organizational congruence, complementarity, and conflict on maintaining linkages once they have been formalized.

Is linkage maintenance made easier if managers understand the partner organization's culture, or are other factors, such as personalities of individual managers or linkage format itself, more important for linkage

management? It was hypothesized in Chapter Three that knowledge of the partner organization's culture would make linkage management easier by requiring managers to devote less time to overseeing linkage activities (Hypothesis G). Put another way, organizational congruence and complementarity should require less management effort, while conflict should require more time and effort.

We have already seen that manufacturing companies and linkage formats associated with product sales to government (i.e., prime contracts, subcontracts and purchase orders) are the primary types of companies and linkages created with NASA to date as shown in Tables 5.22 and 5.23 above. This generates one category of linkage management issues. A second category of management issues is related to R&D companies and their R&D-based linkages (e.g., SBIR grants) for development of new products and technologies. These two domains of linkage activity are the principal contexts for examining the hypothesized relationship between knowledge of organizational culture and linkage management.

In order to answer this question, data about types of linkages and linkage activities by company type was compared to the types of adjustments reported by companies on the survey questionnaire and via interviews. If a sizeable number of adjustments is reported, then increased managerial activity associated with organizational change can be inferred. Furthermore, if adjustments are frequently cited

in areas of active linkage management, such as operation of work groups, decision-making, chain-of-command, resource allocation, and quality control, then high levels of managerial activity can again be inferred. Comparison of these findings with the two linkage contexts, that is, manufacturing and R&D, will indicate whether or not increased managerial activity is associated with a particular type of linkage or with other factors, such as knowledge about organizational culture.

The types of company adjustments required to work with NASA were presented in Table 5.13 (see page 173). Overall, adjustments required by companies to work with NASA reflect a range of operational, organizational, and policy areas. However, organizational and operational areas, including quality control, decision-making, resource allocation, operations, rewards and incentives, work group organization, and so forth, are by far most frequently cited as needing adjustments (66%). Policy areas, such as proprietary rules, strategic planning, risk parameters and licensing rules were not as affected by linkage agreements (26%).

Operational and organizational areas requiring adjustments are more frequently cited by manufacturing companies than by R&D companies. Manufacturing companies more frequently report adjustments in quality control procedures (18%), resource allocation criteria (15%), decision-making (12%), and risk parameters ((11%). R&D

companies report a wide range of adjustments, but decision-making procedures are most frequently cited (22%). This indicates that R&D companies rely on flexible work groups and procedures to produce a wide variety of products and services. Manufacturing companies, on the other hand, are generally characterized by relatively inflexible production technologies, operations, quality control standards, and other organizational constraints. This results from the facts that production processes and equipment are not easily or cheaply altered and that equipment or component parts supplied to NASA under various linkage formats must meet with NASA specifications and approval, even when such specifications require expensive or difficult alterations in production operations. Thus, once the link has been created, fixed adjustments that serve the link are in place and ease adaptation to similar future relations.

Comments provided by executives of manufacturing and R&D companies support the observation that managerial time and effort are significant factors in their linkage experiences. Comments from both types of companies address many operations-related adjustments, including the fact that companies are required to make strict adjustments to decision-making in order to implement new processes mandated by NASA contracts. One informant notes that more people had to be involved in decision-making for longer periods of time, and another relates that staff had to be taken away

from other operations to help meet linkage requirements. Other comments focus on resource allocation (in terms of payment schedules and policies) and contract monitoring, all requiring significant managerial effort. Thus, some linkage arrangements require organizational adaptations to establish congruent or complementary operating formats that, not surprisingly, increase the time and effort of company managers involved with the linkage.

In addition to the types of adaptations made by many companies, the positive or negative effects of various organizational and environmental variables on the linkage outcomes provide additional indications of managerial activity levels. Specifically, conflict resolution by adaptation toward more compatible organizational processes and structure require significant levels of time and effort. Further, the resolution (or lack of resolution) of conflicts gives a glimpse of the difficulty of the problems and the management efforts involved. The greater the difficulty, the greater the level of effort required to manage the linkage.

Several variables are reported to constrain linkage activities as shown in Table 5.21 (page 200). These conflicts include government "red tape," activities of competitors, financial costs to the company, and NASA decision-making procedures.

Government "red tape" is considered to be a `necessary evil,' an 'insoluable problem,' and an element that many companies 'are not organized to address.' These comments illustrate that many small and medium-sized companies lack experience or staff to oversee contracts, comply with NASA accounting requirements, and meet NASA's technical specifications and quality standards, i.e.,to move the organization toward greater congruence or complementarity.

Several company informants feel that NASA tends to create and maintain linkages only with companies that already `know the ropes' of (are congruent with) contract and bidding procedures. Another informant, anexecutive of an R&D company, relates that he was unable to secure an exclusive license from NASA for a device developed by his company through a NASA award.[2] Because of this, one of his competitors is now able to negotiate a license as well, commercially develop the device, and enjoy a sizeable share of the profits. Consequently, competitor activities affect linkage outcomes in certain cases and are likely to require managers to spend time on monitoring them in the interests of protecting company resources.

Financial costs are a major source of frustration for small and medium-sized companies. Slow payments for

[2] An exclusive license agreement means that only one company has the right to continue commercial development of the patented item or technology. Profits are shared by that company and the agency owning the patent.

products, lost invoices, long time periods between company expenditures and government progress payments, and delays caused by drawn-out contract negotiations and audits are noted frequently by executives of both manufacturing and R&D companies. This means that managers must devote extra time to bookkeeping, paperwork, and reassuring uneasy creditors that money is "on the way."

Lower profit margins are a concern of some manufacturing company executives. This is because in order to win contracts it is necessary to underbid competitors. In some cases, companies must underprice their products to such an extent that costs for overhead expenses, component parts, and even salaries are lowered to unrealistic levels. While companies may actually lose money by submitting the lowest price and winning a contract, such activities are not routine for small and medium-sized firms. The strategy reflects the assumption that once a company is "in the door," future contracts and linkages will be easier to establish. Managerial time is thus spent in devising ways to compensate for budgetary shortfalls, developing proposals for future contracts, and satisfying overworked/underpaid contract personnel.[3]

[3] This problem has become acute enough that Congress is now investigating cases of blatant corporate underpricing in contract competition. Most adversely affected are engineers and other professional workers not protected by unions. They are often forced to work long hours, seven days a week to complete complex engineering projects contracted by government in artificially shortened timespans for which

Finally, several general comments about NASA's decision-making procedures include observations that company-NASA communication is extremely difficult, that NASA changes project specifications and requirements in the middle of the program, and that NASA is not supportive of small businesses. Again, such elements imply that additional managerial time and energy are required to maintain communications with NASA, to comply with changing project specifications and schedules, and to overcome perceived image problems with NASA. In other words, managing a linkage requires managers to encourage and shape organizational adaptation toward congruence or complementarity with NASA.

Interestingly, the capabilities of the Joint Endeavor Manager (JEM), a linkage manager, are not viewed as important (83%) or as having any effect on linkage maintenance activities or outcomes (89%). This reflects the fact that the JEM position is not part of the traditional linkage formats of prime contracts, subcontracts and purchase orders. Rather, it is associated with the more innovative joint linkages of the CUS program. It is likely

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they are not compensated for overtime. While many of these individuals eventually are compensated for their efforts via bonuses or additional time off, there are concerns that the government's orientation toward the lowest price is not in its own best interests or in the best interests of the companies that depend on government contracts for the bulk of their income. For additional reading on this issue, please see Duffy (1989: 4, 13).

that recognition of the importance and influence of the JEM position will increase as the linkage formats associated with the CUS program become more commonplace.

To summarize, these comments infer that higher levels of effort are required to maintain company-NASA linkages in cases where there is some organizational conflict between the company and NASA. Managers of R&D and of manufacturing companies must devote time to ensuring that company operations and products are congruent with or complementary to (sometimes changing) NASA specifications, government regulations, resource acquisition and allocation, and competitor strategies.

It is uncertain whether knowledge about NASA (which is universally low among the company executives surveyed and interviewed in this project) shortens the time or moderates the efforts of company managers within a linkage context. One informant, an executive of a small manufacturing company, is emphatic in his warnings to other companies about NASA linkages. As a former NASA engineer, he understands NASA "red tape", procurement regulations, and quality standards. He notes that the NASA manual listing technical specifications and quality standards routinely utilized by his company is approximately four inches thick and saturated with fine print. The book is loose-leaf so that alterations in specifications can be substituted as they arrive from NASA. He maintains that unless individuals

constantly review or, better yet, memorize the information contained in the manual, it is impossible to meet NASA's needs for products in a manner that will benefit the company.

Thus, the implication is clear. Company executives and technical engineers must devote significant time to understanding NASA in order to achieve company goals in a NASA linkage. The continuously changing nature of federal regulations, NASA needs, and linkage activities require significant amounts of time and energy on the part of managers who must oversee and nurture company adaptations to NASA. R&D companies as well as the R&D divisions of manufacturing companies must continuously monitor the activities of competitors to protect their own fledgling R&D projects and associated proprietary interests. While knowledge of NASA at the start of a linkage relationship is advantageous, it is insufficient to minimize the managerial time and effort required to carry out contractual activities, ensure organizational congruence, and manage the linkage.

Organizational Adaptation in Linkage Contexts

It is now possible to address the core question about organizational congruence, complementarity, and conflict in cross-sector interorganizational linkages. Do successful linkage outcomes result from organizational congruence

and/or complementarity or from the specific terms of a particular formalized relationship? Put another way, are linkages a driving force for organizational adaptation and change, as suggested in Hypothesis H?

The answer may be found by reviewing the findings thus far. First, the the adjustments, or adaptations, reported by companies in order to work with NASA, as shown in Table 5.13 on page 176, show that a majority (56%) of companies with NASA links report adjustments in their organization and operations. Manufacturing companies more often note adjustments to their operations, and R&D companies more often note adjustments in decision-making. We have also seen that adjustments are made primarily in the context of the traditional linkage formats (prime contracts, subcontracts and purchase orders) that dominate the experience of the company executives polled in this research. Adjustments are also reported for the substantially fewer innovative agreements, such as SBIR awards, but the low incidence these innovative linkages precludes meaningful assessment.

The adjustments reported by respondents generally reflect areas of organizational conflict that constrain linkage outcomes, including decision-making, operations, and resources/costs, as noted in Tables 5.15 (page 185) and 5.21 (page 200). When asked whether conflicts in the NASA relationship were resolved satisfactorily, 32 (42%) of the

77 companies responding to this question say yes. Another 44 companies (57%) report that conflicts were not resolved, however, and one executive notes that conflicts were only partially resolved. Frustrated executives from these latter companies go on to report that conflicts in company-NASA communication, formal organization and resource acquisition and allocation were largely insurmountable from their perspective. These companies did not adapt toward increased organizational congruence and did not achieve their linkage goals.

From the perspective of the private company partners, adaptations were also required in the course of linkage activities to accommodate NASA's changing project objectives, to improve communications, and to reconcile differing resource allocation and budgetary needs. As such, these are areas in which organizational adaptation and change do or do not occur in linkage contexts, depending on the attitudes and perceptions of company decision makers.

We also note that NASA linkage creation and maintainence involves significant commitment of managerial time and effort to cope with NASA's strict, but changing regulatory, technical, accounting, and other requirements. Once adjustments are made and procedures in place, company executives generally seek specific linkage formats that do not require additional organizational adaptations. That is why companies with prime contracts, subcontracts, and/or

purchase order relationships with NASA wish to pursue similar relationships in the future and offer caveats to other companies seeking NASA linkages.

Similarly, executives who do not desire new or additional NASA linkages frequently cite as reasons their beliefs that their organizational structures, products, and operations conflict with those of NASA. They are unwilling to adapt their companies to NASA's linkage demands because they believe potential company benefits will not outweigh the financial and human costs of adaptation. Consequently, organizational adaptation toward complementarity or congruence with NASA in the interests of linkage creation does not occur. Organizational culture remains in conflict with the specific terms of formal contractual linkages.

The overwhelming majority of the companies in the sample are manufacturing companies with NASA linkages in the form of prime contracts, subcontracts, and purchase orders. Even among R&D companies, a sizeable number of these traditional linkage formats are represented. Thus, at present, existing company-NASA linkage patterns exhibit congruence and complementarity in areas of formal organization, operations, and resource exchange. That is, companies are largely organized to sell products and services to NASA through traditional linkage mechanisms. Further, adaptations in company organization and operations are recognized criteria for creation of NASA linkages.

Whether or not executives choose to alter company organizing principles, operations, resource exchange patterns and other elements depends largely on their own cost-benefit analyses of potential linkage outcomes.

Thus, congruence, complementarity, and conflict between organizational cultures play a significant role in linkage activities, primarily by constraining or facilitating decisions about organizational adaptation. Further, the question of whether or not linkages are a driving force for organizational adaptation is generally answered. Organizations may or may not adapt toward congruence or complementarity in order to create linkages, depending on cost-benefit assessments from a given perspective. It appears that in many cases linkage decisions are based on perceptions about degrees of existing congruence, complementarity, or conflict. If congruence or complementarity already exist, linkage creation is viewed more favorably. Similarly, if organizations are perceived to be in conflict, then linkages are not likely to be sought. Thus, it appears that a priori perceptions about interorganizational congruence, complementarity, or conflict drive linkage creation.

On the other hand, organizational adaptation is a consequence of operating within the context of a formal linkage relationship. Whether or not organizational conflicts are transformed via adaptations toward

interorganizational congruence or complementarity depends in large part on the nature and scope of the consequences of not resolving the conflict or meeting the terms of the contract. Chapter Six discusses the implications of these findings more fully and as they relate to the major propositions outlined in Chapter Three.

CHAPTER SIX

DISCUSSION AND CONCLUSIONS

Introduction

This research set out to accomplish a number of goals. The most general of these was an examination of the nature and extent of the influence of organizational culture on the establishment of formal cross-sector interorganizational relations. To this end, three propositions were presented in Chapter Three: 1) that organizations can be modeled as cultural systems, 2) that interorganizational linkages are established for mutually beneficial purposes, and 3) that organizational culture significantly affects linkage creation and maintenance.

The literature on interorganizational relationships, or linkages, emphasizes resource exchange as the primary driving force for linkage formation. "Resources" are variably defined, but in almost all cases cited in the literature, resource acquisition underlies many of the other purposes postulated for linkage formation, including power and legitimation within an organizational field. Organizational culture, as defined by organization-specific value systems, traditions, expectations, ways of behaving,

decision-making processes, operations, and external environmental characteristics, has not been examined with respect to its influence on linkage creation and maintenance. This research has shown that congruent, complementary, or conflicting organizational cultures do influence interorganizational linkage formation in significant ways.

The second objective of the research was to explore whether or not organizational change and adaptation are consequences of interorganizational linkages. Several findings indicate that linkages do appear to be strong driving forces for organizational change. This can be seen both in the organizations that have adapted isomorphically toward congruence with NASA, such as the tightly woven aerospace industry, and in the positive and negative experiences of the small and medium-sized (nonaerospace) advanced technology firms that have linked to NASA. These latter companies either form or refuse to form linkages with NASA according to perceptions of interorganizational congruence, complementarity or conflict. However, in the context of the linkage relationship, adaptation often occurs as a means to resolve conflicts.

The third objective of the research was to explore the effectiveness of cross-sector interorganizational linkages as a strategy for general technology and economic development as well as for accomplishing the programmatic

goals of the Commercial Use of Space (CUS) policy. Consequently, the research incorporated an evaluative perspective from the standpoint of assessing the effectiveness of new forms of industry-NASA linkages as a principal strategy to stimulate technology and economic development. The following sections discuss the findings and their implications in light of the original objectives of the research.

Cross-Sector Interorganizational Linkages

Similarities and differences between public sector and private sector organizations both drive and constrain linkage formation and the achievement of linkage goals. The literature on interorganizational linkages does not take into account to any meaningful extent the effects of congruent, complementary, and conflicting organizational cultures on linkage development and maintenance. Elements of organizational culture overlooked include internal social formations (including the structure of work groups, decision hierarchies, and communication networks), world views (including the values, attitudes, expectations and goals) of organizational decision makers, and history of interorganizational linkage experiences.

Instead, the literature focuses on a small portion of interorganizational linkage behavior, that of resource exchange between and among organizations. The assumption is

that linkages, or formalized relationships, will be forged between two organizations in order for each to acquire resources necessary to maintain internal operations and to produce outputs. Consequently, virtually all of the investigations of interorganizational linkages to date concentrate on the types of resources exchanged, exchange patterns (both collectivist and individualist), and whether or not the exchange contributes to achieving linkage goals, usually in the context of a particular set of programmatic activities.

Resource exchange is, in fact, a prime motivator for interorganizational linkage formation and maintenance over time. This is demonstrated clearly by the attitudes and expectations expressed by company executives wishing to obtain or to maintain traditional prime contract, subcontract, and purchase order linkages with NASA. They wish to secure lucrative and stable markets for company goods and services, and in so doing, secure a steady supply of capital in the form of profits back into their organizations. This is certainly not surprising given the capitalist market orientation of American business and industry.

However, resource exchange is not the only factor which motivates linkage formation and outcomes, as reported by the company executives participating in this research. A priori perceptions about existing congruence, complementarity, or

conflict between a company and NASA, and willingness or unwillingness to adapt traditional company operations, decision-making, and resource allocation and tracking procedures toward congruence with NASA are primary constraining or driving forces for linkage creation and achievement of linkage goals.

While some might argue that the findings support the contention that resource acquisition is the sole motivator for linkage creation, we believe that organizational culture factors are often stronger determinants of whether or not linkages will be sought. This is true despite the fact that "the bottom line," and econometric cost-benefit parameters inform virtually all strategic decisions and activities within and between business and industrial organizations.

Organizational culture variables influence linkage creation in important ways no matter which of the numerous definitions of organizational culture is used in the analysis. As we saw in Chapter Two, organizational culture is variously defined. Behaviorists utilize individualistic perspectives in their definitions and applications of the concept, while social scientists draw on collectivistic perspectives inherent in the concepts of group and society. Even within anthropology, perspectives on organizational culture mirror differing approaches to the concept of culture in general, notably interpretive versus positivist orientations.

As stated at the outset, this research was not concerned with defining the concept of organizational culture or treating it as the dependent variable. Rather, the concept was examined as an independent variable exerting some measurable impact on interorganizational linkages. For this reason, interpretive perspectives were neither useful nor appropriate. In other instances, however, interpretive perspectives could be appropriate, such as in research on negotiation of a shared frame of reference for interorganizational communication in the context of a linkage.

While this research was organized from a positivist perspective, company informants were encouraged to express their individual attitudes, perceptions, and opinions regarding their organizational linkage experiences. Shared attitudes and values clearly emerged. At the same time, organizational culture as defined by patterns of observable behavior also yielded insight into the concept. As a result, factors influencing linkage creation can be found in at least two alternate formulations of the concept of organizational culture. That is, culture as a shared system of beliefs and values and culture as patterned and observable behavior. Elements of both perspectives were shown to influence linkage creation and outcomes via the eight hypotheses.

Linkages as Determinants of Organizational Adaptation

The problem of organizational change is of paramout interest to scholars, practitioners, and participants alike. Ironically, however, little work has been done to ascertain the effects of interorganizational linkages as driving forces for change and adaptation. As we saw in Chapter Two, several studies refer to adjustments made in the context of program implementation (see, for example Pressman and Wildavsky 1979), and the organization development literature is replete with theoretical models of organizational change via directed intervention strategies in problem-solving efforts. None, however, adequately address organizational change as a response to interorganizational linkages.

DiMaggio and Powell's (1983) formulation of the concept of isomorphism, or the tendency for organizations within a field to become similar to one another over time, is the most relevant work in this regard. Isomorphic tendencies have been clearly demonstrated in the current research in two ways. First, the well defined aerospace industry that dominates company-NASA interaction is similar to the "defense industry" linked with the Department of Defense and the "health care industry" linked to the National Institutes of Health, among others. Over time, aerospace corporations have emulated NASA organizational structure to an extent that strong interorganizational congruence has evolved. There are certainly perceived boundaries between insiders

and outsiders, although such perceptions may characterize outsiders to a greater extent than insiders. Nevertheless, the aerospace industry is almost universally viewed by business executives and government administrators alike as a primary and forceful entity.

Just as observed similarities in form and function between government and aerospace corporations reflect isomorphism, attitudes of executives of small and medium-sized advanced technology companies outside the aerospace industry also reinforce the notion of isomorphism. The research revealed that these executives are reluctant to change their companies' operations and other characteristics to conform to what they believe NASA requires. These executives are also frustrated about what they perceive to be almost insurmountable barriers to accessing NASA presented by the aerospace corporations.

On the other hand, company executives with histories of successful NASA linkages report that either their companies are already compatible with NASA or that the nature of the linkage (i.e., prime contracts, subcontracts, and purchase orders) does not require substantial organizational adaptation on their part. These individuals express satisfaction with the outcomes of their linkage experiences and plan to pursue additional links with NASA.

This research has shown that the DiMaggio and Powell (1983) model of ismorphic change is valid for NASA, the

aerospace industry and for the nonaerospace targets of the Commercial Use of Space (CUS) program. Overcoming the linkage traditions which have evolved since World War II between NASA and the aerospace corporations is a primary challenge for CUS program managers. Further, attempts at establishing new types of linkages within traditionally isomorphic organizational fields are likely to meet with failure unless these dominant traditions are overcome.

The findings also support the notion that congruence and complementarity are strong driving forces for linkage formation. Conflicts (both real and perceived) constrain linkage formation and generally take the form of incompatibilities between NASA's and a company's operating procedures, administrative decision-making, and value systems. Thus, organizations have adapted over time toward congruent or complementary organizational cultures in order to participate in established and traditional linkage formats. Alterations in the formal relationships themselves, however, can and do occur as reported by company informants, transforming achieved congruence and complementarity into conflict. In such instances, linkage managers must try to reduce conflict by establishing new congruence or complementarity in the relationship.

Organizational adaptation toward congruence for the purpose of one general linkage type (e.g., 'buyer-seller' relationships) can also be threatened by the introduction of

new interorganizational linkage formats, as in the case of CUS linkages. In these instances, several consequences are possible. One is active rejection of new linkage formats by decision makers in all organizations, depending on the degree to which the new formats differ from traditional formats and the degree to which organizational cultural characteristics are seen as conflictive, even maladaptive. Rejection is likely both from organizations with histories of successful traditional linkage relationships (such as NASA and industrial contractors) and from organizations that are currently adapting to traditional linkage relationships.

Another consequence can be a reformulation of power and resource patterns within the organizational field. Those organizations that were previously in conflict with traditional organizational linkage formats may suddenly find themselves in a position to capitalize on the emerging new linkage relationships while those with previous congruence find themselves in conflict.

These and other, unanticipated consequences of establishing new interorganizational linkage formats within traditional domains of interorganizational relationships are the driving forces for organizational adaptation. They also are significant for more practical considerations when they are a primary vehicle for policy and program implementation at all levels. Active resistance to the implementation of new linkage formats may result in programmatic changes over

time or outright failure. In the case of large-scale federal policy development, such activities can be and are often devastating. The following section discusses the implications of cross-sector interorganizational linkage formation in the context of national initiatives for advanced technology and economic development.

Linkages as Strategies for Economic Development

Can cross-sector interorganizational linkages bring about technology and economic development? As noted in Chapter One, multiple linkages between and among diverse business and industrial organizations, universities, research institutes, and government agencies are an increasingly popular strategy for accomplishing regional and national economic development goals. Achieving these goals depends on the effectiveness of the cross-sector interorganizational linkages created and maintained for the purpose of transferring critical knowledge and technologies.

A major obstacle for advanced technology development is the clash of value systems, policies, missions and goals of the organizations linked to carry out particular technology development tasks. In other words, organizational culture and the wider cultural context play a dominant role in task activities and achievement.

On one hand, business and industrial organizations are market-driven. That is, organizational stability and

viability over time results from continued and stable profits in often unpredictable market situations. This "market pull" orientation leads company decision makers to weigh costs and benefits of R&D as it relates to technology commercialization and marketability of resulting products. R&D is generally treated as important only if R&D activities can eventually result in marketable and profitable products and services, as was shown in Table 5.1 on page 150.

On the other hand, the "technology push" element of the organizational cultures of universities and government agencies results in a quite different set of organizational missions, policies, operations, and goals. Here, R&D is often undertaken for its own sake, such as in the case of universities or laboratories where scientists and engineers have the time and the capabilities to explore intrinsically interesting technological problems. R&D is also undertaken to solve difficult and specific technical problems, such as those associated with spaceflight for NASA or with toxic waste disposal for the Environmental Protection Agency. In both these cases R&D is characterized as "technology push" as opposed to "market pull." If technology development is critical to economic development, then both market pull and technology push activities must be complementary. In other words, there must be a viable market for the technologies developed in order for economic development to occur.

This research project demonstrates clearly the conflicts between "market pull" and "technology push" orientations to R&D, to the creation and maintenance of cross-sector interorganizational linkage creation (insofar as the CUS program is concerned), and to both the positive and negative experiences of the company executives who link to NASA and other government agencies. NASA with its traditional technology push perspective is exploring ways to link with nontraditional business and industry organizations with market pull (profit) perspectives to undertake joint activities that will result in a greater commercial presence in space-based and space-related domains. Whether or not the new linkage formats emphasized by the Commercial Use of Space program will stimulate organizational adaptation in this direction will not be evident for some time. Unfortunately, the political constraints posed by the federal government in assessing programmatic success for NASA may preclude successful commercial space development given the magnitude of the organizational adaptations required and the lengthy time frames needed for adaptation to occur.

From this standpoint the research findings generally support Shrum's (1982) provocative distinction between R&D and state sociopolitical technical systems. As discussed in Chapter Two, the two types of technical systems are distinguished by the degree and the type of government

intervention. There is comparatively less government involvement in the R&D-type system than in the state sociopolitical system. In the former, government's role is to stimulate technology development in areas where the market is defective. The goal is to support continued development until market forces no longer constrain the process. In the latter, government involvement extends to development of extensive administrative bureaucracies to control the speed and direction of technology R&D, transfer, and, in some cases, commercialization, primarily of spinoff technologies (Shrum 1982: 10-12).

The central finding of this research reinforces Shrum's (1982) distinction between technical system types because both types of systems are present within the purview of the Commercial Use of Space policy and program. Elements of the state sociopolitical system are reflected by the fact that the CUS program originated as a government program with state interests in economic development through government supported R&D in advanced technologies. The particular areas of technology development are those associated with the U.S. civilian space program as it competes with growing space capabilities of other nations. NASA and the aerospace industry have generally been tasked to develop technologies for specific nationalistically-defined programs. Thus, technology development is mandated and directed for the areas of satellite communications, earth and ocean

observation, launch services, materials processing in space, and infrastructural support services.

Elements of R&D investment technical systems are also present in the CUS program, however. These elements are represented chiefly by the goal of eventually commercializing many, if not most, space-based enterprises. Thus, while government also plays a role in developing the technologies necessary for competition in the international space arena, the ultimate goal is to convert much of the activity into market-based industry-driven private enterprise.

Several specific programmatic strategies emphasize industry priorities in this regard. R&D activities conducted via the Centers for the Commercial Development of Space (CCDSs) must meet industry goals and orientations while simultaneously meeting government space technology needs. Similarly, the intent of the new forms of linkage agreements within the CUS program stress greater roles for business organizations in project definition and activities.

Unfortunately, and significantly, the clash of these two systems within the CUS arena hinders not only company-NASA linkage formation but also jeopardizes the achievement of both government and industry goals. The conflicts generated by "market-pull" and "technology-push" orientations are still largely unresolved, and it is likely that they will continue to present formidable problems in

light of increasing international competition for dominance and participation in space-based activities.

For example, it is difficult to convert the launch industry to private enterprise while foreign governments actively subsidize their own launch capabilities. The result is that U.S. companies must pay a much higher price to launch their payloads via a U.S. launch company than via a European, Soviet or Chinese launch service. The U.S. reponse to date has been to restrict access to non-U.S. launch services by American companies in the interests of national security and to maintain some level of state subsidy until the launch industry matures. Whether the private sector launch industry can mature under such conditions of international competition is questionable to many observers, however.

Conflicts generated by the dual representation of both R&D investment and state sociopolitical technical systems occurs at all levels. On a large scale, broad-based government policies attempt to resolve primary and secondary conflicts that hinder policy implementation. The aforementioned launch service regulations are a case in point, as are the creation of consortia in the form of the CCDSs. A further complication is the reluctance of Congressional policy makers to resolve issues relating to industrial policy.

At the level of the individual firm, conflicts are reflected by decisions of executives to link or not link with government according to corporate cost/benefit criteria. Individual decisions are based on individual assessments of the costs of complex space-related technology R&D projects for which markets may or may not emerge. The uncertainty of future benefits in the form of profits is a major barrier, since government will not guarantee long term commitments to purchase resulting technology products and processes. It is not surprising that company executives choose to favor linkage formats that assure company profit goals will be met by short-term sales to government markets.

To summarize, the major findings of the research emphasize that organizational culture both constrains and facilitates the establishment of cross-sector interorganizational linkages. Company informants reveal that they are reluctant to form novel and nontraditional linkages with NASA, but are eager to pursue and to maintain traditional linkage formats. NASA and government in general must address the concerns of company decision makers to achieve the goals of the technical system evolving for commercial space. Congruence and complementarity between and among primary organizational characteristics, such as decision-making, operations, and values systems are critical determinants of successful technology and economic development via linkage strategies. Conflicts over the

values and goals that inform policy and operating procedures for differing technical systems reflect dominant cultural differences between private sector and public sector organizational forms.

Implications for Future Research

This research was designed to provide a foundation upon which subsequent investigations can build. As such it raises many more questions than it answers, and several directions emerge for continued research by anthropologists as well as by researchers in the policy sciences, sociology, psychology, and economics. For anthropologists, particularly, investigation into the emergence and adaptation of complex social formations within and across larger cultural systems is of interest. Comparative studies can shed light on the dynamics of change and adaptation over time, the nature of rapid and deliberate diffusion of technology as a characteristic of complex culture, interaction of diverse organizational forms within specific policy and cultural contexts, and the effectiveness of technical systems in achieving broader economic development objectives. Additionally, the inner workings of technical systems such as that associated with the commercialization of space are fruitful areas for research, including investigation into the nature and effects of professional networks that crosscut organizational boundaries, decision

making processes as well as the relationships between technical researchers and corporate and government decision makers.

Further, this research opens the door to more social scientific involvement in the U.S. civilian space program. Since the space environment will play an increasingly important role over the coming decades, questions about civilian versus military dominance over space activities must be addressed. Civilian interests in the space environment include not only commercial, for-profit activities but also involve significant public interest issues, such as increased critical knowledge about environmental and climatic dynamics, patterns of urbanization, food production, and communications. The international, multicultural nature of each of these domains of activity suggests that anthropologists have vital roles to play as researchers and practitioners. Of course, we can ignore these developments and the space arena. To do so will not only impoverish our own intellectual domain but will deprive humanity of the benefits of anthropological perspectives on the social and cultural impacts of increased space activities.

APPENDIX A

NASA COMMERCIAL SPACE POLICY, OCTOBER 1984

The purpose of this Policy is to prepare NASA for expanding its mission in a new direction--the fostering of commercial enterprises in space. This Policy, and accompanying Implementation Plan were drawn up by representatives from NASA headquarters and field centers. These representatives looked at the commercial possibilities in space and how NASA can encourage more private industrial ventures in orbit. To supplement their perspective, the NASA representatives sought and received advice from experts in industry and universities as well as other outside specialists.

Preamble

The new chapter in the U.S. space program that opened early in this decade with the first flights of the Shuttle is now reaching a new phase: space technology is ripe for its transition from exploration to major exploitation, from experimentation to expanded profitable commercial uses.

To examine the opportunities for and impediments to expanded commercial activities in space, NASA formed a Task Force in mid-1983.

The Task Force's conclusions are straightforward:

- Commercial activities in space by private enterprise should be expanded now if our nation is to retain and improve its leadership in science and technology, its high living standards, and its advantage in international trade.

- National and bureaucratic barriers inhibiting the commercialization of space need to be and can be lessened or removed through joint actions by the Government and private enterprises.

- With firm resolve and the commitment of reasonable resources over a number of years, Government and private enterprise working tegether can turn space into a realm of immense benefit for our nation.

- A positive NASA Commercial Space Policy should be implemented to expedite the expansion of self-sustaining, profit-earning, tax-paying, jobs-providing commercial space activities.

The NASA Commercial Space Policy supports commercial space activities through:

- Reducing the risks of doing business in space to levels competitive with conventional investments.
  - -- To reduce technical risks, NASA will conduct and stimulate additional research relevant to commercial developments in space.
  - -- To reduce financial risks, NASA will provide easy and inexpensive access to orbit as well as to experimental ground facilities.
  - -- To reduce institutional risks, NASA will help remove procedural impediments, offer organizational support, and maintain consistent policies regarding its relationship with commercial space ventures.

- Reaching out and establishing new links with the private sector to stimulate the development of private businesses in space.
  - -- NASA will expand its traditional links with the aerospace industry and academia to also embrace other industries such as new high-technology entrepreneurial ventures and the financial and non-aerospace industrial and academic communities.
  - -- NASA will expand and target dissemination of scientific information to stimulate domestic space commerce projects.

-- NASA will use public announcements, interviews, speeches, press releases, and articles in technical and business journals to provide information about commercialization opportunities and its commercialization activities to industry, academia, and the American public.

Summary of Policy Initiatives

The U.S. National Space Policy makes the development of a climate conducive to expanded private sector investment and involvement in civil space activities a national priority. In accordance with that priority, the National Aeronautics and Space Administration has established a Commercial Space Policy. Its major initiatives are summarized below:

A. Initiatives to stimulate research and development:

1. NASA will aggressively conduct research which enhances and encourages commercial space endeavors.
2. NASA will stimulate private sector research directed toward commercial space ventures by providing seed-funding for private sector R&D initiatives.
3. NASA will encourage the development by the private sector of new support hardware and space-related services which are not essential to maintaining

its basic research and development. NASA shall invest in the development of facilities necessary for commercial uses of space.

4. NASA will support the establishment of Industry/University/Government Advanced Research Institutes for research transferable to space uses and product development.

5. NASA may agree to purchase a commercial space venture's product or service if NASA has a need for the product and if the private entity has significant capital at risk above that covered by the NASA purchase.

6. NASA will expedite decisions regarding proposed NASA/Industry joint endeavors. Procedures for providing a decision with six months regarding such proposals will be established.

B. Initiatives to facilitate access to NASA facilities and equipment:

1. NASA will provide reduced rates for Shuttle flights to commercial ventures during the Research and Development phase if desired by the private entity. NASA shall be entitled to a "quid pro quo" to be negotiated with the private ventures.

2. NASA will provide a capability to integrate and fly a "standard" commercial space payload no later than six months from the time of its entry into

the integration process. This will require simplification of present integration processes and appropriate safety and interface design of the commercial payload.

3. NASA will standardize and increase the number of interfaces in the Orbiter middeck and cargo bay to permit simpler and quicker integration and earlier flights.

4. Unless national security requirements dictate otherwise, NASA will assure a flight for commercial payloads for which integration has been scheduled.

5. NASA will reserve the following Orbiter facilities for commercial ventures: (a) a part of the middeck space and utilities on each civil Shuttle mission, to be held until 20 weeks before launch and then released for other use if no commercial need exists; (b) Orbiter cargo bay space and associated facilities every six months for commercial endeavors which are integrated with pallets or other carriers; (c) access to all or part of a pressurized module flight each year.

6. NASA will make ground test facilities and equipment available at reduced prices for simulation of space environments by commercial endeavors.

C. Procedural initiatives to support Space Commercialization:

1. NASA will not assume a regulatory role with respect to commercial space ventures.
2. NASA will continue to support and assist Federal organizations in defining and applying regulations for commercial space endeavors.
3. NASA will continue to encourage the use of NASA technology, including technology covered by NASA-owned patents in space commercial ventures.
4. NASA will protect proprietary rights, and ask for privately-owned data only when necessary to carry out its responsibilities.
5. During the Research and Development stage of a high-technology commercial venture carried out under a Joint Endeavor Agreement, NASA will not provide reduced-rate or free flights for other technically similar systems.
6. NASA will not undertake development of the same technology which is being developed by U.S. industry for commercial markets under a Joint Endeavor Agreement.

D. Organizational Initiatives to enhance industry access to NASA's focus for commercialization endeavors:

1. NASA will establish special offices at its headquarters and field centers to assist and

encourage private sector involvement in space.

2. NASA will support the establishment of industry advisory boards to provide advice regarding NASA applications-oriented research.

E. Outreach Initiatives to establish new links with the private sector to stimulate private businesses in space.

1. NASA will provide means for developing a continuing dialogue and working relationships with industries and companies that are most likely to establish commercial uses of the space environment.

2. NASA will enhance links between itself, industry, and universities, and solicit the counsel of the financial and insurance communities in decisions regarding space commercialization activities.

3. NASA will review its dissemination methods for science and technology data. With advice from industry, NASA will audit publications procedures to provide better support for the domestic private sector.

4. NASA will encourage the use of specialized firms as intermediaries between the Government and industry to help encourage private involvement in commercial space ventures.

F. NASA Support of the U.S. National Space Policy:

1. NASA will initiate and facilitate actions supporting national commitments to the commercial use of space.

APPENDIX B

DATA COLLECTION INSTRUMENTS

Preliminary Interview Schedule for Survey Development

Date:

Company Name:

Address:

Name of Contact Person:

Phone Number:

1. Have you ever done business with NASA? yes no

IF NO: go to other schedule

IF YES: What type of linkage was involved?

Project Objectives?

Outcomes? (Anticipated and Unanticipated)

Who initiated the linkage?

When:

Biggest problem?

How was the problem solved?

Best thing about the collaboration:

Would you consider expanding your relationship with NASA in the future based on your experience?

How?

Why?

Additional comments:

2. Are your competitors working with NASA?

yes no don't know

Who?

Impact on your company?

3. Would you recommend other companies get involved with NASA, based on your experience? yes no

why or why not?

4. Are you familiar with the Commercial Use of Space program? yes no

If yes, how did you learn about it?

If no, would you like to receive information?

5. Are you familiar with NASA's Technology Utilization program? yes no

If yes, how did you learn about it?

If no, would you like to receive information?

6. Have you ever submitted an SBIR proposal? yes no

If yes, to which agency?

If no, would you like information about the SBIR program?

7. Have you ever linked to other government agencies?

yes no

If yes, which agencies?

what were the outcomes?

were your experiences similar to your NASA experiences?

Questions for companies with no previous business with NASA

1. Have you ever considered doing business or working with NASA? yes no

   Why or why not?

2. Are you familiar with NASA's Commercial Use of Space Program? yes no

   If yes, how did you learn about it?

   If no, would you like to receive information?

3. Are your primary competitors working with NASA?

   yes no don't know

   With a CCDS? yes no don't know

   What is/has been the impact on your company?

4. How significant is R&D to your company's operations?

5. Is the organization able to commit resources to a long-term R&D project?

6. Are you familiar with the attributes of the space environment as an R&D laboratory? (for example, microgravity, vacuum, radiation, etc.)

7. Are you familiar with NASA's Technology Utilization program? yes no

   If yes, how did you learn about it?

   If no, would you like to receive information?

8. Have you ever submitted an SBIR proposal to NASA?

   yes no

9. Have you ever submitted an SBIR proposal to another government agency? yes no

If yes, what agency?

what outcomes?

when?

SMALL HIGH TECHNOLOGY BUSINESS PERCEPTIONS OF
AND EXPERIENCES WITH
THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
(NASA)[1]

General Information and Instructions

The survey questions contained in the following pages are designed to assess the general level of awareness about commercial opportunities in the space program for small and medium sized high technology companies. To this end, questions are designed to collect information about your knowledge of the National Aeronautics and Space Administration (NASA), its Commercial Use of Space programs, characteristics of the space environment for R&D, and the outcomes of past or present NASA-industry relationships.

It does not matter whether your companyhas ever done business with NASA or been involved with NASA in any way. In fact, the responses of companies with no history of involvement with NASA will provide valuable insights into the general perceptions of NASA and perceived benefits from industry involvement in the U.S. space program. These responses will be compared to those from companies which have previous involvement with NASA in order to identify ways whereby NASA-industry relations can be improved and industry benefits can be increased.

The needs of small and medium high technology businesses are different in many respects from those of large corporations which frequently link with NASA for R&D and other purposes. For this reason, your candid and

[1] This survey instrument was actually typeset via a desktop publishing system using a MacIntosh II computer and laser printer and professionally printed onto yellow stock paper. The format is different than that presented here, due to special requirements for dissertation appendices. The questions are the same in content as the original distributed version.

complete responses to the questions in this survey are of great importance. The information which you provide will be used to assist NASA in devising linkages that are more useful and responsive to the needs of small and medium high technology companies.

Names of individuals and companies as well as all other specific information collected in this survey will be kept confidential, will not be published in reports or any other documents, and will not be made available to NASA, any NASA affiliate or another company without prior written permission from the individual and company in question.

The survey is organized in such a way that all respondents will answer the questions in Parts I and II. Questions in Part III should be answered only by those companies that have previous or current relationships with NASA. Questions in Part IV should be answered only by those companies that have had no previous relations with NASA.

Thank you for responding to this survey. If you have any questions or if you would like to receive summary results of the research, please contact:

Ms. Cristy S. Johnsrud
Southern Technology Applications Center
University of Florida
One Progress Blvd., Box 24
Alachua, FL, 32615
or call toll-free:
800-225-0308 (outside Florida)
800-354-4832 (within Florida)

PART I. COMPANY INFORMATION. Please answer the following questions about your company. The information you provide will be used for analysis and comparison of responses in other categories of the survey.

1. Name of company:

   Address:

   Name of Person Responding:

   Title:

   Phone:

2. What year was the company founded? _____

3. Current number of employees:

( ) 1-99 ( ) 100-249 ( ) 250-500

4. Annual Sales Revenues:

( ) less than $1,000,000
( ) $1,000,000 to $25,000,000
( ) $25,000,001 to $50,000,000
( ) $50,000,001 to $100,000,000
( ) over $100,000,000

5. Which one of the following best describes your company?

( ) R&D ( ) Service ( ) Manufacturing
( ) Other (please specify)

6. What percentage of the company's employees are scientists and engineers?

( ) less than 10% ( ) 26 - 75%
( ) 10 - 25% ( ) 76 - 100%

7. What percentage of the company's annual income is from government contracts?

( ) less than 10% ( ) 51 - 75%
( ) 10 - 25% ( ) 76 - 100%
( ) 26 - 50%

8. What is your company's rank in its primary industry? ("Primary industry" refers to general technology, product, or service area, such as biotechnology, software, advanced materials, chemicals, automation, management consulting, etc.)

( ) Top 5 ( ) Top 100
( ) Top 10 ( ) Top 250
( ) Top 20 ( ) Top 500
( ) Top 50 ( ) Top 1000

9. How many companies would you estimate are your competitors within your primary industry?

( ) fewer than 100 ( ) 1501 - 2000
( ) 101 - 500 ( ) more than 2000
( ) 501 - 1000
( ) 1001 - 1500

10. Which of the following (there may be more than one) describe(s) the industry in which your company participates?

( ) heavily regulated by government
( ) strong entry barriers
( ) basic research emphasized
( ) value-added services emphasized
( ) newly emerging
( ) dominated by a few large firms
( ) highly competitive
( ) short product life
( ) dependent on government contracts
( ) stable market
( ) cyclical market
( ) unstable market
( ) others (please list):
( ) _____
( ) _____

11. Please indicate the importance of the following R&D activities to your company.

	Very Imp't	Somewhat Imp't	Not Imp't
Discovery of new knowledge	____	____	____
Technology Transfer	____	____	____
Improve in-house operations	____	____	____
Information research	____	____	____
Modify existing products/services	____	____	____
New product/service development	____	____	____
Develop substitute products	____	____	____
Literature reviews	____	____	____
Other (please specify):			
_____	____	____	____
_____	____	____	____

PART II. KNOWLEDGE ABOUT THE SPACE ENVIRONMENT AND NASA.
(To be answered by all respondents) The following questions are designed to determine the breadth and depth of your knowledge about the space environment, NASA, and commercial opportunities in the space program in general. Please put a checkmark in the column that most closely represents the extent of knowledge in each area on the part of your company's planning and program decision makers.

	Very Familiar	Somewhat Familiar	Not Familiar
12. Attributes of Space			
Microgravity	_____	_____	_____
Solar Radiation	_____	_____	_____
High/Low Temperature	_____	_____	_____
Magnetic Field	_____	_____	_____
Residual Atmosphere	_____	_____	_____
High Vacuum	_____	_____	_____
Extraterrestrial Vantage point	_____	_____	_____
Ionosphere	_____	_____	_____
13. Space-Based Industries			
Materials Processing in Space	_____	_____	_____
Remote Sensing	_____	_____	_____
Satellite Communications	_____	_____	_____
Space Power	_____	_____	_____
Propulsion Systems	_____	_____	_____
On-orbit Payload Processing	_____	_____	_____
Life Sciences	_____	_____	_____
Automation and Robotics	_____	_____	_____
14. Agreements With NASA			
Prime Contract	_____	_____	_____
Subcontract	_____	_____	_____
Joint Endeavor Agreement (JEA)	_____	_____	_____
Memorandum of Agreement (MOA)	_____	_____	_____
Memorandum of Understanding (MOU)	_____	_____	_____
Launch Services Agreement (LSA)	_____	_____	_____
Technical Exchange Agreement (TEA)	_____	_____	_____
Industrial Guest Investigator Agreement (IGI)	_____	_____	_____
Space Systems Development Agreement (SSDA)	_____	_____	_____
Range Use Agreement (RUA)	_____	_____	_____

15. R&D Opportunities			
Centers for the Commercial Development of Space (CCDS)	_____	_____	_____
Shuttle Flights	_____	_____	_____
NASA Field Centers	_____	_____	_____
Federal Laboratories	_____	_____	_____
Small Business Innovation Research (SBIR) program	_____	_____	_____
16. NASA Outreach			
Commercial Use of Space Program	_____	_____	_____
Technology Transfer Programs	_____	_____	_____
NASA Tech Briefs	_____	_____	_____
NASA Spinoff	_____	_____	_____
NASA Industrial Applications Center (IAC)	_____	_____	_____
Space Station activities	_____	_____	_____
Small Business Innovation Research (SBIR) program	_____	_____	_____

PART III. EXPERIENCE WITH NASA. If you answer "yes" to question no. 17 below, please complete this section. If you answer "no" to question no. 17, please skip to Part IV of this survey. Again, all answers will be kept confidential.

17. Have you (personally) or has your company ever done business with NASA?

_____yes _____no

If your answer was "yes," please complete this part of the survey. If your answer was "no," please skip to Part IV of this survey on page 7.

18. Please indicate the number of each type of relationship you have or had with NASA in the blank provided at left. For example, a "0" means no relationships of a given type, while a "2" means that you have had two relationships of a given type.

Number of Relationships	Type of Relationship
( )	Prime Contract
( )	Subcontract with a NASA Prime Contractor
( )	Memorandum of Understanding (MOU)
( )	Technical Exchange Agreement (TEA)
( )	Industrial Guest Investigator (IGI)
( )	Memorandum of Agreement (MOA)
( )	Launch Services Agreement (LSA)
( )	Space Systems Development Agreement (SSDA)
( )	Joint Endeavor Agreement (JEA)
( )	Range Use Agreement (RUA)
( )	Center for the Commercial Development of Space (CCDS)
( )	Small Business Innovation Research (SBIR) Award
( )	Purchase Order
( )	Other (please specify): _____

19. Please indicate the nature of the activities for which the relationship is/was contracted. If you indicated more than one relationship with NASA in question no 18, please specify which relationships were associated with which activities below (e.g., (x) R&D subcontract, SBIR, IGI).

Activity	Type of Relationship
( ) R&D	_____
( ) Services	_____
( ) Hardware	_____
( ) Business Development	_____
( ) Other (please specify):	_____

20. Who initiated your first relationship with NASA?

( ) you personally
( ) another executive in your company
( ) an executive of another company
( ) a NASA Headquarters representative
( ) a NASA Field Center representative
( ) a NASA Industrial Applications Center (IAC) representative
( ) a university
( ) othe (please specify):

21. What year was the first relationship initiated? _____

22. What type of relationship was the first relationship?

( ) Prime Contract
( ) Subcontract with a NASA Prime Contractor
( ) Memorandum of Understanding (MOU)
( ) Technical Exchange Agreement (TEA)
( ) Industrial Guest Investigator (IGI)
( ) Memorandum of Agreement (MOA)
( ) Launch Services Agreement (LSA)
( ) Space Systems Development Agreement (SSDA)
( ) Joint Endeavor Agreement (JEA)
( ) Range Use Agreement (RUA)
( ) Center for the Commercial Development of Space (CCDS)
( ) Small Business Innovation Research (SBIR) Award
( ) Other (please specify):
_____

23. How long did it take to finalize the first relationship?

( ) Less than six months ( ) 12 - 18 months
( ) 6 - 9 months ( ) 18 - 24 months
( ) 9 - 12 months ( ) over 24 months

24. Who initiated subsequent relationships with NASA?

( ) not applicable
( ) you personally
( ) another executive in your company
( ) an executive of another company
( ) a NASA Headquarters representative
( ) a NASA Field Center representative
( ) an Industrial Applications Center representative
( ) a university
( ) other (please specify):
_____

25. The following items represent a number of possible goals and objectives for which relationships with NASA can be pursued. Please indicate how important each of the following goals are/were in your company's relationship(s) with NASA.

Goals	Very Imp't	Somewhat Imp't	Not Imp't
New product development	_____	_____	_____
Develop NASA as a client/market	_____	_____	_____
Improve existing products	_____	_____	_____
Conduct basic research	_____	_____	_____
Increase profit/returns	_____	_____	_____
Access new technologies/information	_____	_____	_____
Support U.S. space program	_____	_____	_____
Access NASA facilities/expertise for R&D	_____	_____	_____
Strengthen in-house R&D capabilities	_____	_____	_____
Secure seed funding for business start-up	_____	_____	_____
Improve the company's competitiveness	_____	_____	_____
Other (please specify):			
_____	_____	_____	_____

26. Were the goals and objectives you indicated above as "very important" met in the relationship?

_____yes _____no _____partially

27. Which of the goals and objectives inidicated as "very important" in question no. 25 were not met or only partially met?

_____

_____

_____

28. How important are/were each of the following items in determining the outcomes of your relationship with NASA?

	Very Imp't	Somewhat Imp't	Not Imp't
Insurance coverage	_____	_____	_____
Agreement negotiation process	_____	_____	_____
Access to the space environment	_____	_____	_____
Flight scheduling	_____	_____	_____
Number of flights available	_____	_____	_____
Access to NASA Field Center facilities	_____	_____	_____
NASA decision-making procedures	_____	_____	_____
Government "red tape"	_____	_____	_____
Attitudes of NASA representatives	_____	_____	_____
Attitudes of company stakeholders	_____	_____	_____
NASA proposal review process	_____	_____	_____
Previous company experience with NASA	_____	_____	_____
Proprietary considerations	_____	_____	_____
Financial costs to the company	_____	_____	_____
NASA Industrial Applications Centers (IACs)	_____	_____	_____
Capability of the Joint Endeavor Manager (JEM)	_____	_____	_____
Adjustments to normal company operations	_____	_____	_____
Patent licensing issues	_____	_____	_____
Company decision-making procedures	_____	_____	_____
Company R&D resources	_____	_____	_____
Activities of competitors	_____	_____	_____
Company-NASA communications	_____	_____	_____
Unforeseen market shifts	_____	_____	_____
Success of Prime Contractor	_____	_____	_____
Other (please specify):	_____	_____	_____

29. Please indicate whether the following items had a positive, a negative, or no effect on the outcomes of the relationship:

	Positive Effect	No Effect	Negative Effect
Insurance coverage	_____	_____	_____
Agreement negotiation process	_____	_____	_____
Access to the space environment	_____	_____	_____
Flight scheduling	_____	_____	_____
Number of flights available	_____	_____	_____
Access to NASA Field Center facilities	_____	_____	_____
NASA decision-making procedures	_____	_____	_____
Government "red tape"	_____	_____	_____
Attitudes of NASA representatives	_____	_____	_____
Attitudes of company stakeholders	_____	_____	_____
NASA proposal review process	_____	_____	_____
Previous company experience with NASA	_____	_____	_____
Proprietary considerations	_____	_____	_____
Financial costs to the company	_____	_____	_____
NASA Industrial Applications Centers (IACs)	_____	_____	_____
Capability of the Joint Endeavor Manager (JEM)	_____	_____	_____
Adjustments to normal company operations	_____	_____	_____
Patent licensing issues	_____	_____	_____
Company decision-making procedures	_____	_____	_____
Company R&D resources	_____	_____	_____
Activities of competitors	_____	_____	_____
Company-NASA communications	_____	_____	_____
Unforeseen market shifts	_____	_____	_____
Success of Prime Contractor	_____	_____	_____
Other (please specify):	_____	_____	_____

30. Were any of the negative effects indicated above resolved satisfactorily from your perspective?

_____yes _____no

Please explain (use separate sheet if needed):

_____

_____

_____

_____

31. Please indicate which of the following areas required significant adjustments in order for your company to work with NASA:

( ) proprietary rules
( ) licensing rules
( ) normal operations
( ) normal organization of workgroups
( ) normal chain-of-command structures
( ) legal staff
( ) existing agreements with other companies
( ) normal resource allocation criteria
( ) strategic planning practices
( ) reward and incentive system
( ) normal decision-making procedures
( ) normal quality control procedures
( ) normal risk taking parameters
( ) other (please specify):
_____

Please explain (use separate sheet if needed):
_____
_____
_____

32. Do you plan to pursue relationships with NASA in the future, based on your previous experiences?

_____ yes _____no

Why or why not?
_____
_____
_____

33. Based on your experience(s) would you recommend that other small and medium-sized businesses pursue relationships with NASA?

_____ yes _____ no

Why or why not?
_____
_____
_____

34. Have you also done business with government agencies other than NASA?

_____ yes _____no

35. If your answer to question no. 34 was "yes," what are those other agencies?

( ) Department of Defense
( ) Department of Energy
( ) Department of Transportation
( ) Environmental Protection Agency
( ) National Science Foundation
( ) National Institutes of Health
( ) Health and Human Services
( ) Federal Laboratories
( ) Other (please specify):

_____
_____

36. If you answered "yes," to question no. 34, were your experiences with other federal agencies better, about the same, or worse than your experience(s) with NASA in the categories listed below?

	Better	Same	Worse	N/A
Insurance coverage	____	____	____	____
Agreement negotiation process	____	____	____	____
Access to agency facilities	____	____	____	____
Agency decision-making procedures	____	____	____	____
Agency "red tape"	____	____	____	____
Attitudes of agency representatives	____	____	____	____
Attitudes of company stakeholders	____	____	____	____
Agency proposal review process	____	____	____	____
Previous company experience with the agency	____	____	____	____
Proprietary considerations	____	____	____	____
Financial cost to the company	____	____	____	____
Capability of the agreement manager	____	____	____	____
Patent licensing issues	____	____	____	____
Company decision-making procedures	____	____	____	____
Company R&D resources	____	____	____	____
Activities of competitors	____	____	____	____
Company-agency communications	____	____	____	____
Unforeseen market shifts	____	____	____	____
Success of Prime Contractor	____	____	____	____
Other (please specify):	____	____	____	____

_____

37. If you would like to make any additional comments about your experiences with NASA which you feel are relevant but which have not been addressed by any of the above questions, please do so here or on separate paper:

_____

_____

_____

_____

Thank you for participating in this survey. We appreciate your time and effort. Please contact us if you would like to receive a copy of the research report or if you have any questions or comments you wish to add to this research project.

PART IV. PERCEPTIONS ABOUT NASA.

If your answer to question no. 17 in Part III of this survey was "no," please answer the following questions. If your answer to question no. 17 in Part III was "yes," do not answer the following questions.

38. Have you ever seriously considered the possibility of doing business with NASA?

_____ yes _____ no

39. If your answer to question no. 38 above was "yes," did you follow up on the idea?

_____ yes _____ no

Please explain: _____
_____
_____

40. If you answered "no" to either question no. 38 or 39 above, please indicate which of the following items (there may be more than one) correspond to your reasoning:

( ) Too risky
( ) Too long to negotiate agreements
( ) No access to the space environment
( ) NASA wouldn't want to buy my product
( ) NASA has too much "red tape"
( ) Federal government in general has too much "red tape"
( ) NASA is controlled by the military
( ) NASA proposal review process is too lengthy
( ) Unhelpful NASA representatives
( ) Too expensive
( ) Company stakeholders would not support
( ) No reason to fly on the Shuttle
( ) Launch insurance/third party liability issues
( ) NASA would not protect company's proprietary interests
( ) Don't know how to access NASA representatives
( ) Never thought about it
( ) Other (please specify): _____
_____

41. Are any of your primary competitors working with NASA?

_____yes _____no _____don't know

42. Are any of your primary competitors affiliated with a Center for the Commercial Development ofSpace (CCDS)?

_____yes _____no _____don't know

43. Have you ever submitted a Small Business Innovation Research (SBIR) proposal to NASA?

_____yes _____no

If yes, what was the outcome?

_____
_____

44. Have you ever submitted a Small Business Innovation Research (SBIR) proposal to other government agencies?

_____yes _____no

45. If your answer to question no. 44 was "yes," to which government agencies did you send your SBIR proposal?

( ) Department of Defense
( ) Department of Energy
( ) Department of Transportation
( ) Environmental Protection Agency
( ) National Science Foundation
( ) Health and Human Services
( ) National Institutes of Health
( ) Other (please specify):

_____
_____

46. What was the outcome of your SBIR proposal efforts?

_____
_____

47. Have you ever been contacted by a NASA or a NASA -affiliated representative about opportunities which may exist for your company in space or in a space-related project?

_____yes _____no

48. If the answer to question no. 47 was "yes," what form did the contact take? Please check all relevant items below:

( ) A mailed brochure or other printed material
( ) Telephone call
( ) Visit to your company
( ) Seminar/conference presentation
( ) Trade show booth or presentation
( ) Other (please specify): _____
_____

49. If your answer to question no. 47 was "yes," did you have a clearer understanding of potential opportunities for your company with NASA at the conclusion of that contact?

_____yes _____no

50. If you did not have a clearer understanding, please indicate which of the following factors was a reason for the lack of clarity:

( ) presentation emphasized scientific aspects
( ) presentation was too technical
( ) failed to relate to business goals
( ) too much information given in too short a time
( ) presentation did not apply to characteristics of the company's primary industry
( ) presentation not oriented toward company's products/services
( ) NASA organization difficult to understand
( ) other (please specify): _____
_____

51. Have you ever utilized a NASA Industrial Applications Center (IAC) for information research?

52. If you would like to make any additional comments about NASA and/or other federal agencies which you feel are relevant, but which have not been addressed by any of the above questions, please do so here:

_____
_____
_____
_____

Thank you for participating in this survey. We appreciate your time and effort. Please contact us if you would like to receive a copy of the research report or if you have any questions or comments you wish to add to this research project.

APPENDIX C

SUMMARY QUESTIONNAIRE RESPONSES WITH SELECTED TABLES

GENERAL INFORMATION

Sample size: 1200

Sample Companies: U.S. owned, for-profit, $100 million or less in annual sales

Respondants: 403

Technology Areas Represented By Respondants Compared with Whether or Not They Have Done Business with NASA (n=403)

Technology Area:	Total (%)	Yes (%)	No (%)
Automation	60 (15%)	30 (50%)	30 (50%)
Biotechnology	24 (7%)	4 (17%)	20 (83%)
Chemicals	11 (3%)	4 (36%)	7 (64%)
Energy	20 (5%)	6 (30%)	14 (70%)
AI Software and Hardware	9 (2%)	4 (44%)	5 (56%)
Manufacturing	19 (5%)	6 (32%)	13 (68%)
Advanced Matcrials	31 (8%)	12 (39%)	19 (61%)
Medical	20 (5%)	9 (45%)	11 (55%)
Pharmaceuticals	1 (.2%)		1 (100%)
Photonics/Optics	61 (15%)	27 (44%)	34 (56%)
Services (AI, AUT, MFG, MAT, PHA, PHO, MED, CHEM, ENR, BIO)	78 (19%)	31 (40%)	47 (60%)
Testing and Measurement	64 (16%)	22 (34%)	42 (66%)
Unlabeled	5 (2%)	4 (80%)	1 (20%)
Totals	403	159 (39%)	244 (61%)

PART I: COMPANY INFORMATION

1. Distribution of All Respondents by State (n = 397)

	Done Business With NASA?					
	Total	Yes	(%)	No	(%)
South:						
Alabama	1	0		1	(100)
Arkansas	2	2	(100)	0	
Florida	14	9	(64)	5	(36)
Georgia	2	0		2	(100)
Kentucky	1	0		1	(100)
Mississippi	1	0		1	(100)
N. Carolina	4	3	(75)	1	(25)
Oklahoma	3	2	(67)	1	(33)
S. Carolina	4	2	(50)	2	(50)
Texas	14	7	(50)	7	(50)
Tennessee	3	2	(67)	1	(33)
TOTAL	49	27	(55)	22	(45)
Northeast:						
Connecticut	12	4	(33)	8	(67)
Deleware	2	0		2	(100)
Massachussetts	29	19	(65)	10	(35)
Maryland	6	3	(50)	3	(50)
New Hampshire	7	5	(71)	2	(29)
New Jersey	28	10	(36)	18	(64)
New York	28	12	(43)	16	(57)
Pennsylvania	21	10	(48)	11	(52)
Virginia	6	3	(50)	3	(50)
West Virginia	1	0		1	(100)
TOTAL	140	66	(47)	74	(53)
West						
Arizona	2	1	(50)	1	(50)
California	85	35	(41)	50	(59)
Colorado	9	4	(44)	5	(56)
New Mexico	6	2	(33)	4	(67)
Nevada	1	1	(100)	0	
Oregon	10	1	(10)	9	(90)
Utah	3	2	(67)	1	(33)
Washington	6	1	(17)	5	(83)
Wyoming	1	0		1	(100)
TOTAL:	123	47	(38)	76	(62)

(cont.)	Done Business With NASA?				
	Total	Yes	(%)	No	(%)
Midwest					
Iowa	1	1	(100)	0	
Illinois	14	4	(29)	10	(71)
Indiana	5	1	(20)	4	(80)
Kansas	2	0		2	(100)
Michigan	15	5	(33)	10	(67)
Minnesota	7	1	(14)	6	(86)
Missouri	5	1	(20)	4	(80)
Nebraska	3	0		3	(100)
Ohio	24	4	(17)	20	(83)
South Dakota	1	0		1	(100)
Wisconsin	8	1	(13)	7	(87)
TOTAL:	85	18	(21)	67	(79)

3. Number of Employees

1 - 99	309	(77%)
100 - 249	61	(15%)
250 - 500	24	(6%)
over 500	5	(1%)
	403	

4. Annual Sales Revenues

0 - $1 million	122	(30%)
$ 1 - 25 million	240	(60%)
$25 - 50 million	19	(5%)
$50 -100 million	13	(3%)
over $100 million	4	(1%)
	403	

5. Type Of Company (Some chose more than one category)

	% = n/403		% = n/457
R&D	93	(23%)	(20%)
Services	51	(13%)	(11%)
Manufacturing	276	(68%)	(60%)
Other	37	(9%)	(8%)
	457		

6. Proportion of Scientists and Engineers

0 - 10%	(low)	106	(26%)
10 - 25%	(medium)	149	(37%)
26 - 75%	(high)	109	(27%)
75 -100%	(high)	39	(10%)
		403	100%

7. Percent of Income from Government Contracts

1 - 10%	263	(66%)
10 - 25%	50	(13%)
26 - 50%	38	(10%)
51 - 75%	23	(6%)
76 - 100%	23	(6%)
	397	101%

8. Company's rank in primary industry

Rank	No.	%
Top 5	159	40%
Top 10	64	16%
Top 20	28	7%
Top 50	27	7%
Top 100	22	6%
Top 250	13	3%
Top 500	13	3%
Top 1000	36	9%
N/R	41	10%
Total	403	101%

9. Number of Competitor Companies Within Primary Industry

Number	Responses	%
Fewer than 100	315	78%
101-500	39	10%
501-1000	19	5%
1001-1500	5	1%
1501-2000	5	1%
More than 2000	14	4%
No Response	6	2%
Total	403	101%

10. Characteristics of Company Respondent's Industry

Characteristic	Frequency	(%)
Heavily regulated by government	78	(19%)
Strong entry barriers	83	(21%)
Basic research emphasis	109	(27%)
Value-added services emphasis	128	(32%)
Newly emerging	131	(33%)
Dominated by a few large firms	88	(22%)
Highly competitive	200	(50%)
Short product life	48	(12%)
Dependent on government contracts	66	(16%)
Stable market	99	(25%)
Cyclical market	84	(21%)
Unstable market	48	(12%)
Other	32	(8%)

11. Importance of R&D Activities

	Importance (%)			
Activity	Very	Somewhat	Not	N/R
Discovery of New Knowledge	223 (55)	128 (32)	32 (8)	20 (5)
Technology Transfer	162 (40)	170 (42)	44 (11)	27 (7)
Improve In-house Operations	193 (48)	153 (38)	25 (6)	32 (8)
Information Research	96 (24)	189 (47)	81 (20)	37 (9)
Modify Existing Products or Services	191 (47)	157 (39)	38 (9)	17 (4)
New Product/Service Development	320 (79)	62 (15)	11 (3)	10 (3)
Develop Substitute Products/Services	102 (25)	174 (43)	97 (24)	30 (7)
Literature Reviews	56 (14)	195 (48)	119 (30)	33 (8)

PART II. KNOWLEDGE ABOUT THE SPACE ENVIRONMENT AND NASA
(n = 403)

	FAMILIARITY			
	Very(%)	Somewhat(%)	Not(%)	N/R(%)
12. Attributes of the Space Environment				
Microgravity	15 (4)	103 (26)	269 (67)	16 (4)
Solar Radiation	46 (11)	153 (38)	190 (47)	14 (4)
High/Low Temperature	77 (19)	161 (40)	154 (38)	11 (3)
Magnetic Field	30 (7)	143 (36)	216 (54)	14 (4)
Residual Atmosphere	14 (4)	90 (22)	285 (71)	14 (4)
High Vacuum	68 (17)	137 (34)	187 (40)	11 (3)
Extraterrestrial Vantage Point	13 (3)	62 (15)	315 (78)	13 (3)
Ionosphere	11 (3)	98 (24)	278 (69)	16 (4)
13. Space Industries				
MPS	14 (4)	139 (35)	232 (58)	18 (5)
Remote Sensing	48 (12)	156 (39)	182 (45)	17 (4)
Satellite Communications	30 (7)	161 (40)	196 (49)	16 (4)
Space Power	19 (5)	98 (24)	269 (67)	17 (4)
Propulsion Systems	20 (5)	84 (21)	283 (70)	16 (4)
On-Orbit Payload Processing	5 (1)	57 (14)	322 (80)	19 (5)
Life Sciences	26 (7)	107 (27)	254 (63)	16 (4)
Automation & Robotics	60 (15)	170 (42)	157 (39)	16 (4)
14. NASA Agreements				
Prime Contract	56 (14)	76 (19)	253 (63)	18 (5)
Subcontract	60 (15)	119 (30)	208 (52)	16 (4)
Joint Endeavor Agreement (JEA)	4 (1)	26 (7)	356 (88)	17 (4)
Memorandum of Agreement (MOA)	5 (1)	35 (9)	346 (86)	17 (4)
Memorandum of Understanding (MOU)	4 (1)	37 (9)	344 (85)	18 (5)
Launch Services Agreement (LSA)	1 (.2)	7 (2)	377 (94)	18 (5)
Technical Exchange Agreement (TEA)	1 (.2)	33 (8)	351 (87)	18 (5)
Industrial Guest Investigator Agreement (IGI)	1 (.2)	12 (3)	372 (92)	18 (5)
Space Systems Development Agreement (SSDA)	1 (.2)	7 (2)	377 (94)	18 (5)

(cont.)

	FAMILIARITY			
	Very(%)	Somewhat(%)	Not(%)	N/R(%)
Range Use Agreement	1 (.2)	6 (2)	377 (94)	19 (5)
15. R&D Opportunities				
Centers for the Commercial Development of Space (CCDS)	5 (1)	34 (9)	344 (86)	19 (5)
Shuttle Flights	20 (5)	105 (26)	259 (64)	18 (5)
NASA Field Centers	16 (4)	80 (20)	288 (72)	18 (5)
Federal Laboratories	38 (10)	116 (29)	236 (59)	12 (3)
Small Business Innovation Research Program (SBIR)	109 (27)	117 (29)	163 (40)	14 (4)
16. NASA Outreach				
Commercial Use of Space (CUS)	10 (3)	101 (25)	276 (69)	16 (4)
Technology Transfer Programs	13 (3)	122 (30)	256 (64)	12 (3)
NASA Tech Briefs	97 (24)	119 (30)	176 (44)	11 (3)
NASA Spinoff	15 (4)	64 (16)	306 (76)	18 (5)
Industrial Application Centers (IAC)	4 (1)	52 (13)	332 (82)	15 (4)
Space Station	9 (2)	41 (10)	338 (84)	15 (4)
Small Business Innovation Research Program (SBIR)	104 (26)	122 (30)	162 (40)	15 (4)

PART III. EXPERIENCE WITH NASA

17. Have you (personally) or has your company ever done business with NASA?

yes: 158 (39.2%) no: 245 (60.8%) n = 403

18. Types of company-NASA linkages reported:

Type of Relationship	Number of companies reporting at least one relationship (n = 157)	
Prime Contract	58	(37.0%)
Subcontract with a NASA Prime Contractor	73	(46.0%)
Memorandum of Understanding (MOU)	1	(.6%)
Technical Exchange Agreement (TEA)	2	(1.2%)
Industrial Guest Investigator (IGI)	0	
Memorandum of Agreement (MOA)	1	(.6%)
Launch Services Agreement (LSA)	1	(.6%)
Space Systems Development Agreement (SSDA)	0	
Joint Endeavor Agreement (JEA)	0	
Range Use Agreement (RUA)	0	
Center for the Commercial Development of Space (CCDS)	2	(1.2%)
Small Business Innovation Research (SBIR)	25	(15.9%)
Purchase Order	85	(54.1%)
Other	16	(10.2%)

19.

Activity	Frequency	(%)
R&D	70	(25.1%)
Services	32	(11.5%)
Hardware	153	(54.8%)
Business Development	11	(3.9%)
Other	13	(4.7%)
Total	279	

20. Who initiated your first relationship with NASA?

Variables	Frequency	(%)
You, personally	43	(28.1%)
Another executive in your company	40	(26.1%)
An executive of another company	14	(9.2%)
A NASA Headquarters representative	10	(6.5%)
A NASA Field Center representative	15	(9.8%)
A NASA Industrial Applications Center representative	2	(1.3%)
A university	3	(2.0%)
Other	26	(17.0%)
Total	153	(100%)

21. Year first relationship initiated:

Year	Frequency (%)
1958	2 (1.4%)
1960	1 (0.7%)
1962	3 (2.1%)
1963	2 (1.4%)
1964	3 (2.1%)
1965	11 (7.7%)
1966	3 (2.1%)
1967	3 (2.1%)
1968	3 (2.1%)
1969	1 (0.7%)
1970	10 (7.0%)
1971	3 (2.1%)
1972	2 (1.4%)
1973	1 (0.7%)
1974	3 (2.1%)
1975	8 (5.6%)
1976	5 (3.5%)
1977	4 (2.8%)
1978	2 (1.4%)
1979	2 (1.4%)
1980	6 (4.2%)
1981	4 (2.8%)
1982	5 (3.5%)
1983	6 (4.2%)
1984	8 (5.6%)
1985	16 (11.2%)
1986	12 (8.4%)
1987	10 (7.0%)
1988	4 (2.8%)
Total:	143

22. Type of first relationship: (n = 153)

Relationship	Frequency (%)
Prime Contract	40 (26.0%)
Subcontract with a NASA Prime Contractor	34 (22.2%)
Memorandum of Understanding (MOU)	0
Technical Exchange Agreement (TEA)	1 (0.6%)
Industrial Guest Investigator (IGI)	0
Memorandum of Agreement (MOA)	1 (0.6%)
Launch Services Agreement (LSA)	0
Space Systems Development Agreement	0
Joint Endeavor Agreement (JEA)	0
Range Use Agreement (RUA)	0

(cont.)

Relationship	Frequency (%)
Center for the Commercial Development of Space (CCDS)	2 (1.3%)
Small Business Innovation Research Award (SBIR)	11 (7.2%)
Purchase Order	54 (35.3%)
Other	10 (6.5%)

23. How long did it take to finalize the first relationship?

(n = 156)

Time period	Frequency (%)
Less than six months	79 (50.6%)
6-9 months	36 (20.5%)
9-12 months	22 (14.1%)
12-18 months	13 (8.3%)
18-24 months	1 (0.6%)
Over 24 months	5 (3.2%)

24. Who initiated subsequent relationships with NASA?
(n = 156, however respondents chose more than 1 answer)

Variable	Frequency (%)
Not Applicable	39 (25.0%)
You, personally	39 (25.0%)
Another executive in your company	35 (22.4%)
An executive of another company	6 (3.9%)
A NASA Headquarters representative	9 (5.8%)
A NASA Field Center representative	15 (9.6%)
An Industrial Applicatons Center (IAC) representative	2 (1.3%)
A university	6 (3.9%)
Other	18 (11.5%)

25. See Table 5.14 on page 183.

26. Were the goals and objectives you indicated above as "very important" met in the relationship?

yes: 51 (39.5%) no: 30 (23.3%) partially: 48 (37.2%)

27. See Table 5.15 on page 185.

28. Importance of the following items in determining the outcomes of the company-NASA linkage: (n = 145)

Variables	Very Imp't (%)	Somewhat Imp't (%)	Not Imp't (%)	N/R
Insurance coverage	3 (2)	18 (12)	117 (81)	7
Agreement negotiation process	26 (18)	51 (35)	62 (43)	6
Access to the space environment	6 (4)	16 (11)	114 (77)	9
Flight scheduling	5 (3)	10 (7)	121 (83)	9
Number of flights available	4 (3)	7 (5)	124 (86)	10
Access to NASA Field Center facilities	12 (8)	27 (19)	98 (68)	8
NASA decision-making procedures	39 (27)	45 (31)	55 (38)	6
Government "red tape"	38 (26)	50 (34)	50 (34)	7
Attitudes of NASA representatives	52 (36)	42 (29)	44 (30)	7
Attitudes of company stakeholders	8 (6)	28 (19)	100 (69)	9
NASA proposal review process	39 (27)	46 (32)	53 (37)	7
Previous company experience with NASA	25 (17)	56 (39)	54 (37)	10
Proprietary considerations	29 (20)	40 (28)	68 (47)	8
Financial costs to the company	44 (30)	43 (30)	52 (36)	6
NASA Industrial Applications Centers	6 (4)	14 (10)	112 (77)	13
Capability of Joint Endeavor Manager (JEM)	5 (3)	6 (4)	120 (83)	14
Adjustments to normal company operations	12 (8)	35 (24)	88 (61)	10
Patent licensing issues	11 (8)	23 (16)	101 (79)	10
Company decision-making procedures	19 (13)	42 (29)	75 (52)	9

(cont.)	Very Imp't (%)	Somewhat Imp't (%)	Not Imp't (%)	N/R
Variables				
Company R&D resources	39 (27)	44 (30)	56 (39)	6
Activities of competitors	27 (19)	48 (33)	62 (43)	8
Company-NASA communications	30 (21)	48 (33)	58 (40)	9
Unforeseen market shifts	14 (10)	21 (14)	101 (70)	9
Success of Prime contractor	32 (22)	32 (22)	69 (48)	12

29. See Table 5.21 on page 200.

30. Were any of the negative effects indicated above resolved satisfactorily from your perspective?

yes: 32 (22.9%)
no: 44 (31.4%)
partially: 1 (0.7%)
N/R: 63 (45.0%)

31. See Table 5.13 on page 176.

32. Do you plan to pursue relationships with NASA?

yes: 113 (71.9%)
no: 16 (10.2%)
maybe: 1 (0.6%)
N/R: 27 (17.2%)
Total: 157

33. Do you recommend other companies pursue NASA linkages?

yes: 119 (75.8%)
no: 16 (10.2%)
maybe: 2 (1.3%)
N/R: 20 (12.7%)
Total: 157

34. Linkage activity with other federal agencies (n = 157

yes: 143 (91.1%) no: 8 (5.1%) N/R: 6 (3.8%)

35. Linkage activity with other federal agencies (n = 157) (Respondents chose more than 1 agency.)

Agency	Number	Proportion
Department of Defense	129	86.0%
Department of Energy	82	54.7%
Federal Laboratories	65	43.3%
National Institutes of Health	43	28.7%
Environmental Protection Agency	36	24.0%
Department of Transportation	35	23.3%
National Science Foundation	35	23.3%
Health and Human Services	14	9.3%
Other	17	11.3%

36. Were linkages experiences better, about the same or worse than your NASA linkage experience? (n = 152)

Variable	Better Than NASA	Same As NASA	Worse Than NASA	N/A	N/R
Insurance coverage	3 (2)	63 (41)	4 (3)	61 (40)	21
Agreement negotiation process	16 (11)	85 (56)	22 (15)	13 (9)	16
Access to agency facilities	9 (5)	80 (53)	15 (10)	32 (21)	16
Agency decision-making procedures	14 (9)	87 (57)	20 (13)	17 (11)	15
Agendy "red tape"	17 (11)	73 (48(	32 (21)	14 (9)	16
Attitudes of agency representatives	11 (7)	98 (65)	19 (16)	9 (6)	15
Attitudes of company stakeholders	3 (2)	83 (55)	1 (1)	47 (30)	19
Agency proposal review process	10 (7)	82 (54)	20 (13)	22 (15)	18
Previous company experience with the agency	15 (10)	88 (58)	8 (5)	24 (16)	17
Proprietary considerations	9 (5)	83 (55)	10 (7)	34 (22)	17
Financial cost to the company	13 (9)	87 (57)	18 (12)	15 (10)	19
Capability of the agreement manager	11 (7)	90 (59)	6 (4)	28 (18)	17
Patent licensing issues	3 (2)	72 (47)	3 (2)	56 (37)	18

(cont.) Variable	Better Than NASA	Same As NASA	Worse Than NASA	N/A	N/R
Company decision-making procedures	4 (3)	99 (65)	3 (2)	28 (18)	18
Company R&D resources	4 (3)	96 (63)	4 (3)	30 (20)	18
Activities of competitors	8 (5)	80 (53)	15 (10)	31 (20)	18
Company-agency communications	14 (9)	83 (55)	13 (9)	23 (15)	19
Unforeseen market shifts	2 (1)	67 (44)	6 (4)	58 (38)	19
Success of Prime Contractor	9 (.6)	67 (44)	4 (3)	51 (34)	21

37. Comments: See text in Chapters 4 and 5.

PART IV. RESPONSES FROM COMPANIES WITH NO NASA LINKAGE EXPERIENCE

38. Have you ever seriously considered the possibility of doing business with NASA? (n = 240)

Yes: 111 (46.2%) No: 129 (53.8%)

39. If yes, did you follow up on the idea? (n = 111)

Yes: 36 (32.4%) No: 69 (62.2%) N/R: 6 (5.4%)

40. If no to either of the above questions, which of the following reflect your reasons? (n = 179)

Reason:	Frequency (%)
Too risky	11 (6.1%)
Too long to negotiate agreements	44 (24.6%)
No access to space environment	39 (21.8%)
NASA wouldn't want to buy my product	31 (17.3%)
NASA has too much "red tape"	51 (28.5%)
Federal government in general has too much "red tape"	72 (40.2%)
NASA is controlled by the military	8 (4.5%)

(cont.)

Reason:	Frequency (%)
NASA proposal review process is too lengthy	21 (11.7%)
Unhelpful NASA representatives	2 (1.1%)
Too expensive	28 (15.6%)
Co. stakeholders would not support	2 (1.1%)
No reason to fly on the shuttle	26 (14.5%)
Launch insurance/3rd party liability	5 (2.8%)
NASA would not protect company's proprietary concerns	12 (6.7%)
NASA would not grant exclusive patent licenses	8 (4.5%)
Don't know how to access NASA representatives	94 (52.5%)
Never thought about it	69 (38.5%)
other	31 (17.3%)

41. Are any of your primary competitors working with NASA?

Yes:	34 (14.3%)
No:	30 (12.6%)
Don't know:	174 (73.1%)
Total:	238

42. Are any of your primary competitors affiliated with a Center for the Commercial Development of Space (CCDS)?

Yes:	3 (1.2%)
No:	27 (11.2%)
Don't know:	212 (87.6%)
Total:	242

43. Have you ever submitted a Small Business Innovation Research proposal to NASA? (n = 234)

Yes:	19 (8.1%)
No:	215 (91.9%)

If yes, what was the outcome? (n = 19)

Won:	3 (15.8%)
Lost:	11 (57.9%)
Mixed:	2 (10.5%)
N/R:	3 (15.8%)

44. Have you ever submitted a Small Business Innovation Research proposal to other government agencies? (n = 239)

Yes: 74 (31%) No: 165 (69%)

If yes, to which government agencies did you send your SBIR proposal?

Agency	Number	Proportion (n=74)
Department of Defense	36	48.6%
National Institutes of Health	25	33.8%
Health and Human Services	17	23.0%
Department of Energy	16	21.6%
National Science Foundation	15	20.3%
Department of Transportation	3	4.1%
Environmental Protection Agency	3	4.1%
Other	3	4.1%

46. What was the outcome of your SBIR proposal efforts?

Won: 32 (42.7%)
Lost: 22 (29.3%)
Mixed: 18 (24.0%)
N/R: 3 (4.0%)

47. Have you ever been contacted by NASA or a NASA-affiliated representative about opportunities which may exist for your company in space or in a space-related project/? (n = 243)

Yes: 13 (5.3%)
No: 221 (90.9%)
N/R: 9 (3.7%)

48. If the answer to question no. 47 was 'yes,' what form did the contact take? Please check all relevant items below:

Type of Contact:	Frequency (%) (n = 13)
A mailed brochure or other printed material	5 (38.5%)
Telephone call	5 (38.5%)
Visit to your company	2 (15.4%)
Seminar/conference presentation	0
Trade show booth or presentation	2 (15.4%)
Other	4 (30.7%)

49. If your answer to question no. 47 was 'yes,' did you have a clearer understanding of potential opportunities for your company with NASA at the conclusion of that contact?

Yes: 6 (46.2%) No: 7 (53.8%)

50. Factors contributing to lack of clarity: (n = 7)

Factor:	Frequency (%)
Presentation emphasized scientific aspects	0
Presentation was too technical	0
Failed to relate to business goals	0
Too much information given in too short a time	0
Presentation did not apply to characteristics of the company's primary industry	3 (43%)
Presentation not oriented toward company's products/services	1 (14%)
NASA organization difficult to understand	0
Other	1 (14%)
N/R	3 (43%)

51. Have you ever utilized a NASA Industrial Applications Center (IAC) for information research?

Yes: 14 (6%) No: 219 (94%)

52. Comments: See text in Chapters 4 and 5.

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BIOGRAPHICAL SKETCH

I am fortunate to have been able to pursue my interests in anthropology in a variety of ways. My formal training began in archaeology and moved through physical anthropology and linguistics to cultural anthropology. I received a B.A. with honors from the University of Nebraska-Lincoln with a major in anthropology in 1972. A master's degree followed in 1975, also from the University of Nebraska-Lincoln. My master's thesis reflected my growing fascination with complex formal organizations and voluntary associations.

From 1975 to 1982 I was a member of the faculty of Des Moines Area Community College (DMACC). While at DMACC I taught courses in anthropology (all four subfields), sociology, and English and participated in designing the new undergraduate liberal arts core curriculum. In 1982 I began doctoral studies in cultural anthropology at the University of Florida (Gainesville). Here, research into formal organization focused on the U.S. space program, technology transfer, high technology economic development, organizational linkages, and evaluation research formed the basis for my dissertation and for continuing research.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Ronald Cohen, Chairman
Professor of Anthropology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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